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An Assessment of Data Quality and Quantity from Airborne Cloud Physics Projects From 1974 Through 1984

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December 1985
Final Report

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16. Abstract Most of the principal airborne cloud physics projects over the past decade are reviewed here to assess the quantity, quality, and availability of microphysical data from clouds above the freezing level. In particular, available information from the projects is analyzed to determine whether adequate data on supercooled liquid water content (SLWC) and snow currently exist for reliably characterizing aircraft icing conditions at altitudes up to 30,000 feet (9 km) over the conterminous United States (CONUS). About 1700 flights in cold clouds over CONUS are documented, and the number and value of flights having data on SLWC, snow, and other hydrometeors are tabulated. Our assessment for SLWC is that there have been an adequate number of flights into supercooled clouds, but there are often serious disagreements between independent LWC indicators when the LWC is greater than about 1 g/m ³ . Retroactive probe calibration checks in a calibrated, wet wind tunnel may be required to verify individual LWC probe responses or to produce correction factors for past measurements. Our assessment for snow is that the amount of data appears to be adequate for characterizing the sizes and abundance of snow particles at flight altitudes, but about 40% of the data will be from impactors or replicators. If one is willing to accept coarse size and shape classifications, then the existing size and shape tabulations for these data will be of value. Otherwise, tedious and time consuming re-analyses of the original images would be required and the use of the impactor and replicator data may therefore be impractical.			
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ABBREVIATIONS

AES	-	Atmospheric Environment Service (of Canada)
AFB	-	Air Force Base
AFGL	-	Air Force Geophysics Laboratories
AIDJEX	-	Arctic Ice Dynamics Joint Experiment
AIMCS	-	Airborne Investigation of Mesoscale Convective Systems
ALPEX	-	The Alpine Experiment
AMTEX	-	Air Mass Transformation Experiment
AOML	-	Atlantic Oceanographic and Meteorological Laboratory (of NOAA)
APL	-	Applied Physics Laboratory (of Johns Hopkins University)
ARC	-	Alberta Research Council (of Canada)
ASI	-	Aero Systems, Inc.
ASL	-	Above Sea Level
ASSP	-	Axially Scattering Spectrometer Probe
CCOPE	-	Cooperative Convective Precipitation Experiment
CIC	-	Colorado International Corporation
CONUS	-	Conterminous United States
COSE	-	Colorado Orographic Seeding Experiment
CRADP	-	Colorado River Augmentation Demonstration Project
CRBPP	-	Colorado River Basin Pilot Project
CRMWD	-	Colorado River Municipal Water District
CSD	-	Convective Storms Division (of NCAR)
CSI	-	Convergence Systems, Inc.
CSIRO	-	Commonwealth Scientific and Industrial Research Organization (of Australia)
CYCLES	-	Cyclonic Extratropical Storms
DFVLR	-	Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt. (German Aerospace Research Establishment)

DRI - Desert Research Institute (of the University of Nevada)
 EPOCS - Equatorial Pacific Ocean Climate Study
 ERL - Environmental Research Laboratories (of NOAA)
 FAA - Federal Aviation Administration
 FACE - Florida Area Cumulus Experiment
 FEDSIM - Federal Computer Performance Evaluation and Simulation Center
 FSSP - Forward Scattering Spectrometer Probe
 HIPLEX - High Plains Cooperative Program
 HRD - Hurricane Research Division (of NOAA/AOML)
 JW - Johnson-Williams
 LAMP - Laboratoire Associe' de Meteorologie Physique (of the Universite' de Clermont II, Aubiere, France)
 LSCS - Large Scale Clouds Systems
 LWC - Liquid Water Content
 MASEX - Mesoscale Air Sea Experiment
 MIT - Massachusetts Institute of Technology
 MIZEX - Marginal Ice Zone Experiment
 MRI - Meteorology Research, Inc.

 NACA - National Advisory Committee for Aeronautics
 NAE - National Aeronautical Establishment (of the National Research Council of Canada)
 NASA - National Aeronautics and Space Administration
 NCAR - National Center for Atmospheric Research
 NEWS - New England Winter Storms
 NEXRAD - Next Generation Weather Radar
 NHEML - National Hurricane and Experimental Meteorology Laboratory (of NOAA)
 NHRE - National Hail Research Experiment
 NHRL - National Hurricane Research Laboratories (of NOAA)

NMIM&T - New Mexico Institute of Mining and Technology
 NOAA - National Oceanic and Atmospheric Administration
 NOSC - Naval Ocean Systems Center
 NRL - Naval Research Laboratory
 PACE - Precipitation Augmentation for Crops Experiment
 PEP - Precipitation Enhancement Project
 PMEL - Pacific Marine Environmental Laboratories (of NOAA)
 PMS - Particle Measuring Systems, Inc.
 RAF - Research Aviation Facility (of NCAR), or
 - Royal Air Force (of the United Kingdom)
 SAS - Statistical Analysis System
 SCPP - Sierra Cooperative Pilot Project
 SDSM&T - South Dakota School of Mines and Technology
 SESAME - Severe Environmental Storms and Mesoscale Experiment
 SLWC - Supercooled Liquid Water Content
 SMONEX - Summer Monsoon Experiment
 STREX - Storm Transfer and Response Experiment
 TRIP - Thunderstorm Research International Project
 UND - University of North Dakota
 USAF - United States Air Force
 UWA - University of Washington
 UWY - University of Wyoming
 VFR - Visual Flight Rules
 WMONEX - Winter Monsoon Experiment
 1D-C - One Dimensional Cloud Droplet Size Spectrometer
 1D-P - One Dimensional Precipitation particle size spectrometer
 2D-C - Two Dimensional Cloud droplet imaging probe
 2D-P - Two Dimensional Precipitation particle imaging probe

ABBREVIATIONS (Continued)

Abbreviations for Names of States

AR - Arkansas
CA - California
CO - Colorado
CT - Connecticut
DC - District of Columbia
FL - Florida
IL - Illinois
IN - Indiana
KS - Kansas
MA - Massachusetts
MD - Maryland
ME - Maine
MI - Michigan
MT - Montana
NC - North Carolina
ND - North Dakota
NE - Nebraska
NH - New Hampshire
NM - New Mexico
NY - New York
OH - Ohio
OK - Oklahoma
PA - Pennsylvania
SD - South Dakota
TX - Texas
WA - Washington
WI - Wisconsin
WV - West Virginia
WY - Wyoming

EXECUTIVE SUMMARY

This report covers one phase of a continuing research project to improve the understanding and quantitative description of aircraft icing conditions in the atmosphere. The project is the first of its kind since the late 1940's. At that time, data were first collected on the frequency of occurrence of temperatures, and of sizes and water content of unfrozen droplets in subfreezing clouds - the principal source of ice accumulation on aircraft in flight. These data were collected on dedicated research flights by scientists from the Weather Bureau and the National Advisory Committee for Aeronautics (NACA). Until the present project, these original data formed the basis of current descriptions of the icing environment for aircraft. Extreme values and interrelationships between temperature, water content, effective droplet diameter, and horizontal extent of cold clouds at altitudes up to 22,000 ft. (6.7 km) have been promulgated in the Federal Aviation Regulations, Part 25 (FAR-25), Appendix C. These extreme values and interrelationships (termed characterizations) have been in use since the early 1950's as specifications for the design of ice protection equipment on transport category aircraft.

An initial phase of the present project made use of the original NACA data and an equal amount of "modern" data (7000 miles of inflight measurements in all) to establish a new, previously unavailable characterization of icing conditions expressly for altitudes up to 10,000 ft (3 km). These altitudes are of interest because most helicopter operations take place within this range. Most of the modern data was obtained from a few publicly funded field experiments in cloud physics and weather modification research. This availability of data from other projects was particularly valuable because the considerable expense of new, dedicated research flights was avoided.

The present project also includes plans to re-evaluate the characterizations in FAR-25, Appendix C, and to expand the amount and type of data available to manufacturers about icing conditions. Eventually, plans include the addition of available modern data from worldwide geographic locations and first time characterizations of snow, ice particles, freezing rain, and supercooled fog. These plans may only be affordable if, as before, a sufficient amount of good quality data is already available from properly instrumented research flights in cold clouds. Thus, the current phase of the project has now included a comprehensive survey of cloud physics and weather modification research flights which took place over the past ten years.

The present report details the results of that survey on the availability and probable utility of recent airborne cloud physics measurements, primarily over the United States and Canada. The survey indicates that an adequate amount of data is available from clouds at subfreezing temperatures, but there will be some problems with liquid water measurements in severe icing conditions. There will also be difficulty in processing snow and ice crystal data beyond coarse categorizations of size, shape, and mass. Finally, a review is given of the current status of the project and of the continually growing, computerized data base.

INTRODUCTION

The FLight Safety Branch of the Federal Aviation Administration (FAA) Technical Center has been recently pursuing a careful re-evaluation of existing characterizations of cold cloud properties related to aircraft icing conditions. These characterizations are promulgated in the Federal Aviation Regulations, Part 25 (FAR-25), Appendix C. The characterizations, often referred to as FAR-25 "envelopes", are intended to delimit the extreme values of supercooled liquid water content (SLWC) and median volume diameter (MVD) of droplets in cold clouds at any altitude as a function of air temperature. These envelopes are used for environmental criteria by aircraft manufacturers in the design of anti-icing or de-icing equipment. The FAA uses them to specify environmental conditions for demonstration flights in the process of certifying aircraft for flight in icing conditions.

Some of the principal tasks involved in the re-evaluation are:

1. Re-examine for accuracy and reliability the 30-35 year old measurements on which the FAR-25 envelopes are based.
2. Collect a comparable amount of modern data on SLWC, MVD, and horizontal extent in a wide variety of cold cloud types and weather situations over the altitude range of 0-10,000 ft (3 km) over the conterminous United States (CONUS).
3. Analyze and compare the old and new data and derive a reliable characterization of SLWC and MVD for the 0-10,000 ft range over CONUS.
4. Assess the quality, quantity, and availability of modern data on:
 - a) SLWC and MVD at altitudes above 10,000 ft over CONUS,
 - b) SLWC and MVD at all altitudes worldwide,
 - c) Snow at all altitudes over CONUS,
 - d) Snow at all altitudes worldwide.
5. Collect and process additional CONUS data from all altitudes for inclusion in the data base developed from items 1-3 above.

The first three of these items have been completed and the results are documented in FAA technical reports by Jeck (1983) and Masters (1983). Items 4a, 4c and 5 are the subject of the present report.

RESULTS

For the purposes of this report, an attempt has been made to obtain at least some elementary information about the major airborne research projects during the past decade which involved measurements of LWC, droplet sizes, and solid particles in clouds at altitudes above the freezing level. The search has been limited to the past ten years (1974-1984) primarily because of the availability of automated particle size spectrometers by Particle Measuring Systems, Inc. (PMS) during that period, and because original data any older are less likely to be available anymore, at least not in a convenient form.

The large scale, multiple participant projects are well documented and data inventories or field summary reports are readily available from central archiving offices. Projects of this type include the High Plains Cooperative Program (HIPLEX) and the Sierra Cooperative Pilot Project (SCPP) administered by the Bureau of Reclamation, U. S. Department of the Interior. Other examples are the Severe Environmental Storms And Mesoscale Experiment (SESAME) and the Florida Area Cumulus Experiment (FACE) sponsored by the National Oceanographic and Atmospheric Administration.

Most other projects involving only one or two agencies or institutions are less well documented. One must often rely on internal technical reports, unpublished data catalogs, voice transcripts or flight notes from the scientific crew, and on occasional research papers published in the meteorological journals.

In the course of this work, some 55 different, single- or multi-year projects have been identified in which research aircraft participated for a total of some 2144 flights days. Most (1677) of these flights took place over the U.S. or Canada, but some (467) occurred at various locations around the world. The emphasis has been on projects within the U.S. and Canada, however, so the search for "foreign" projects has not been at all exhaustive. No doubt there are even a few projects in the U. S. that have not come to the author's attention. For the same reason, some projects may have involved more flights than are listed here. Information on such projects will be welcomed for inclusion into a final compilation.

A list of the airborne research projects considered for this report are given in Tables 1 and 2. Yearly summaries of the number of flights, instrument availability, and types of data from the known projects are given in Table 3. The Appendix contains similar information from the individual aircraft participating in each project.

The principal items of interest initially are the dates and locations of the flights, the aircraft involved, the cloud physics instrumentation in use, the types of clouds encountered, the cloud penetration altitudes, and the availability of data to prospective users.

Table 1. PROJECTS WITH CLOUD PHYSICS DATA ABOVE THE FREEZING LEVEL

<u>Project</u>	<u>Date</u>	<u>-----Location-----</u>	<u>Participants with Cloud Physics Aircraft</u>
<u>1984</u>			
TRIP	Jul-Aug	New Mexico	NCAR, NMIM&T
MIZEX	Jun-Jul	Greenland and vicinity	DFVLR
NOAA/UND Co-op	Jun-Jul	North Dakota	UND
AIMCS	Jun-Jul	OK, CO, WY	NOAA
Maypole-II	May-Jun	Colorado	NCAR, SDSM&T
ER-2 Thunderstorms	May	Kansas	UND
ARC Snowpack	Feb	Alberta, Canada	ARC
NASA Icing	Jan-May	U.S. Great Lakes vicinity	NASA/Lewis
SCPP	Jan-Mar	California	UWY, UND
Chinook Helo Trials	Jan-Mar	Nova Scotia, Canada	RAF/Boeing Vertol
Cloud Chemistry	Jan-Feb	Washington	UWA
NASA-CAR	Jan	Washington	UWA
Lake Effect Snow	Dec-Jan	Lake Michigan vicinity	NCAR
<u>1983</u>			
NEWS	Nov-Dec	Northeastern United States	NCAR
Cloud Chemistry	Aug,Sep,Nov	Washington	UWA
Hurricane Studies	Aug-Oct	W. Atlantic, Gulf of Mexico, E. Pacific	NOAA/HRD
NEXRAD Support	Jun-Aug	Massachusetts	UND
GROSSVERSUCH-IV	Jun-Jul	Switzerland	SDSM&T
Alberta Hail	May-Aug	Alberta, Canada	ARC
Cumulus Studies	Apr-Nov	Washington	UWA
SCPP	Jan-Mar	California	UWY, UND
ARC Snowpack	Mar,Nov,Dec	Alberta, Canada	ARC
MIZEX-West	Feb	Bering Sea	NOAA
NASA Icing	Jan-Mar	U.S. Great Lakes vicinity	NASA/Lewis
CRADP	Jan-Feb,Nov	Colorado	UND
MASEX	Jan	offshore New Jersey	NOAA
NEWS	Dec-Jan	Northeastern United States	NCAR

Table 1. PROJECTS WITH CLOUD PHYSICS DATA ABOVE THE FREEZING LEVEL (Continued)

<u>Project</u>	<u>Date</u>	<u>Location</u>	<u>Participants with Cloud Physics Aircraft</u>
<u>1982</u>			
Hurricane Studies	Sep	W. Atlantic, E. Pacific	NOAA/NHRL
GROSSVersuch-IV	Aug	Switzerland	SDSM&T
Alberta Hail	Jun-Sep	Alberta, Canada	ARC
ALPEX	Mar-Apr	southern Europe	NOAA, NCAR, DFVLR
ARC Snowpack	Mar	Alberta, Canada	ARC
Upslope Clouds	Mar-May	Colorado	UND
SCPP	Jan-Mar	California	UWY, UND
Ice Xtals/Upslope Storms	Jan-Feb	Colorado	NOAA/ERL
CYCLES	Jan	Washington	UWA, NOAA
COSE-III	Dec-Jan	Colorado	CIC, NOAA
<u>1981</u>			
Hurricane Studies	Sep	western Atlantic	NOAA/NHRL
CCOPE	May-Jul	Montana	AES, UWY, NCAR, UND, SDSM&T, DRI
Cloud Chemistry	May-Sep	Washington	UWA
Cumulus Studies	Mar-Aug	Washington	UWA
NRL Icing	Mar-Apr	eastern United States	NRL
AFGL Icing	Mar-Apr	IN, NY, MA, ME	USAF/AFGL
LSCS	Mar-Apr	WI, ME, NY, NH	USAF/AFGL
PEP	Feb-May	Spain	UWY, LAMP
Cloud Seeding	Feb-Mar	Utah	UWA
Lake Effect Snow	Dec-Jan	Lake Michigan vicinity	UWY, NCAR

Table 1. PROJECTS WITH CLOUD PHYSICS DATA ABOVE THE FREEZING LEVEL (Continued)

<u>Project</u>	<u>Date</u>	<u>-----Location-----</u>	<u>Participants with Cloud Physics Aircraft</u>
<u>1980</u>			
Hurricane Studies	Aug	Carribean Sea, Gulf of Mexico	NOAA/NHRL
PACE	Aug	Illinois	UWY
FACE-II	Jun-Aug	Florida	ASI
Arctic Stratus	June	Beaufort Sea	NCAR
HIPLEX	May-Jul	Montana, Texas	UWY, CIC, AES, CRMWD, NCAR
Cumulus Studies	Mar-May	Washington	UWA
PEP	Feb-May	Spain	UWY
EPOCS	Feb-Apr	eastern equatorial Pacific	NOAA
Cloud Seeding	Feb-Apr	Washington	UWA
CYCLES	Feb	Washington	UWA
AFGL Icing	Jan-May, Oct, Dec	OH, IL, NC, WA, ME, NY, CO, WI, MI	USAF/AFGL
LSCS	Jan-May, Oct, Dec	WA, NE, PA, MA, OH	USAF/AFGL
SCPP	Jan-Mar	California	UWY, ASI
<u>1979</u>			
Ice Xtals/Upslope Storms	Dec	Colorado	NCAR
AFGL Icing	Dec	WV, IL, MI	USAF/AFGL
COSE-II	Nov-Dec	Colorado	NCAR, CIC
Hurricane Studies	Aug-Sep	Carribean Sea, Gulf of Mexico	NOAA/NHRL
FACE-II	Jul-Aug	Florida	ASI
TRIP	Jul-Aug	New Mexico	NCAR
SMONEX	Jun-Jul	Arabian Sea, Bay of Bengal	NOAA, NCAR
HIPLEX	May-Jul	MT, TX, SD, ND	UWY, CIC, AES, CRMWD, MRI
LSCS	Apr, Aug	WA, CA, MA, TX, IL	USAF/AFGL
SESAME	Apr-Jun	Oklahoma	SDSM&T, NCAR
PEP	Mar-May	Spain	UWY, LAMP
NRL Icing	Mar	U.S. Great Lakes vicinity	NRL
Cloud Seeding	Feb, Nov, Dec	Washington	UWA
CYCLES	Feb-Mar, Nov-Dec	Washington	UWA, USAF/AFGL
Hurricane Studies	Feb-Mar	southwest Pacific	NOAA/NHRL
SCPP	Jan-Mar	California	UWY, ASI
COSE-I	Jan-Mar	Colorado	CIC
Cirrus Studies	Jan-Feb	NM, CO, TX, CA	USAF/AFGL

Table 1. PROJECTS WITH CLOUD PHYSICS DATA ABOVE THE FREEZING LEVEL (Continued)

<u>Project</u>	<u>Date</u>	<u>-----Location-----</u>	<u>Participants with Cloud Physics Aircraft</u>
	<u>1978</u>		
WMONEX	Dec	South China Sea, Java Sea	NOAA, NCAR
Lake Effect Snow	Nov-Dec	Lake Michigan vicinity	NCAR
Hurricane Studies	Sep	Carribean, Gulf of Mexico, W. Atlantic	NOAA/NHRL
Cirrus Studies	Aug-Sep	OK, KS, NY	MRI, Aeromet
TRIP	Aug	Florida	SDSM&T
NCAR/CSD Field Season	Jul	Colorado	SDSM&T
FACE-II	Jun-Aug	Florida	ASI, UWY, NOAA
Summer Cumulus	Jun-Jul	Ontario, Canada	AES
NHRE	Jun-Aug	Colorado, Wyoming	UWY, SDSM&T, NCAR
PACE	Jun	Illinois	NOAA
HIPLEX	May-Jul	MT, TX, KS	UWY, MRI, CIC, CRMWD
LSCS	Mar	NM,AR,TX,OK,IL,PA, W. Atlantic	USAF/AFGL
EAE	Jan-Feb	Colorado	NCAR
SCPP	Dec-Mar	California	UWY
	<u>1977</u>		
Lake Effect Snow	Nov-Dec	Lake Michigan vicinity	NCAR
Hurricane Studies	Aug-Oct	Carribean, Mexico, W. Atlantic, E. Pacific	NOAA/NHRL
Cloud Seedability	Jul	Illinois, Georgia	NOAA
Summer Cumulus	Jun-Jul	Ontario, Canada	AES
HIPLEX	May-Jul	MT, CO, TX	UWY, MRI, CIC
SCPP	Jan-Mar	California	UWA

Table 1. PROJECTS WITH CLOUD PHYSICS DATA ABOVE THE FREEZING LEVEL (Continued)

<u>Project</u>	<u>Date</u>	<u>-----Location-----</u>	<u>Participants with Cloud Physics Aircraft</u>
	<u>1976</u>		
Hurricane Studies	Jun-Sep	W. Atlantic, E. Pacific	NOAA/NHRL
FACE	Jun-Aug	Florida	NOAA/NHEML
Summer Cumulus	Jun-Jul	Northwest Territories, Canada	AES
NHRE	Jun-Jul	Colorado	UWY, NCAR, SDSM&T
HIPLEX	Apr-Jul	Montana	MRI, CSI, UWA
Wx Erosion	Jan-Oct	eastern U.S., W. Pacific	MRI, Aeromet, USAF/AFGL
	<u>1975</u>		
HIPLEX	Jun-Sep	Montana	CSI, UWA, MRI
Summer Cumulus	Jul	Northwest Territories, Canada	AES
AIDJEX	Jul	Beaufort Sea	NCAR
NHRE	Jul	Colorado	SDSM&T
FACE	Jul	Florida	NOAA/NHEML
AMTEX	Feb	East China Sea	NCAR
Wx Erosion	Jan-Jun	eastern United States	USAF/AFGL
CRBPP	Dec-Mar	Colorado	UWY
	<u>1974</u>		
Wx Erosion	Jan-Jun	eastern United States	USAF/AFGL
Ice Clouds	Jan-Apr	north & northwestern U.S., Canada	MRI

Table 2. SOME PROJECTS WITH NO CLOUD PHYSICS DATA ABOVE THE FREEZING LEVEL

<u>Project</u>	<u>Date</u>	<u>Location</u>	<u>Participant Aircraft</u>	<u>Comments</u>
Deep Convection	Apr-May, 1984	Oklahoma	NOAA, NASA	No cloud penetrations
AGASP	spring, 1983	Arctic	NOAA	Clear air only
Polar Lows	Jan-Feb, 1984	Iceland, Greenland, Norway	NOAA/ERL, NASA	Remote sensing only
EPOCS	Jun-Jul, 1981	offshore,so.Calif.	NOAA/ERL	Warm Sc
Marine Stratus	May-Aug, 1981	offshore,so.Calif.	NOSC	Warm Sc
STREX	Nov 1980	Gulf of Alaska	UWA,AES,NOAA/PMEL	Below 0°C level
JASIN	Aug,Sep, 1978	15°W, 60° N	UK Met Ofc.,DFVLR,NCAR	Warm Sc

Assessment of Data for Supercooled Liquid Water

Table 3 provides a summary of flights from the projects that were known to the author at the time of this writing. For the purposes of the NRL/FAA Data Base it is important to note that a good percentage (70% or about 1500 flights) of the total number of flights were instrumented with both a JW LWC probe and either an ASSP or FSSP droplet size spectrometer. These are the flights of principal interest because simultaneous dropsize and LWC measurements are two of the basic variables needed. Also, these flights provide two independent measurements of LWC. Redundant measurements are important for judging the accuracy and reliability of the data. In practice it is often found that either the JW or the droplet size spectrometer consistently indicate significantly greater LWCs than the other, especially for LWCs greater than about 1 g/m^3 . In most cases the ASSP or FSSP undercounts the actual number of droplets present. The LWCs computed from the recorded size spectra are then found to be less than the JW LWCs typically by a factor of two to ten. The problem of undercounting is usually due to a particle incidence rate that exceeds the capability of the PMS probe to respond correctly to each individual droplet transiting the sampling volume of the probe. Excessive rates can result from airspeeds of the order of 200 kt or greater, from droplet concentrations of the order of 500 cm^{-3} or greater, from incorrect delay times in the particle-counting circuitry, or from a combination of these factors (Cerni, 1983; Dye and Baumgardner, 1984). In the newer FSSPs, data lines are provided for monitoring the circuit responses to the particle rate so that correction factors can be computed. The ASSPs and the older FSSPs usually do not have these auxiliary data lines, and corrections are not as easy to make. Sometimes a constant correction factor is possible for small values of LWC.

The JW is not always trustworthy either. Occasionally the JW may indicate LWCs that appear to be erroneously large. Such an example is described later in item 2d) of the section on Current Status of the NRL/FAA Data Base. The indicated LWCs are particularly suspicious when, without corroboration from some other measurement, they approach or exceed the maximum LWC allowed from adiabatic lifting theory. Experience has shown that the adiabatic limit is rarely approached in most clouds. Typically, LWCs observed in convective clouds are less than about two-thirds of the adiabatic limit, while in stratiform clouds the LWCs average about half of the adiabatic limit.

Sometimes the LWC indicated by the JW is significantly less than the LWC computed from the droplet size spectra. This can happen when the de-icing heater in the JW probe is inoperative and a buildup of ice around the orifice distorts the airflow. Sometimes faulty electrical grounding occurs in a corroded or loose connector and can cause some of these responses (Strapp and Schemenauer, 1982).

These problems are not uncommon, and they demonstrate the need for redundant measurements, careful maintenance, and constant attention from an experienced scientist or technician during each flight. They also indicate that retroactive calibrations in a calibrated wet wind tunnel may be necessary for some of these probes before the data can be trusted for use in the NRL/FAA Data Base.

Tunnel calibrations may not always help, however. NASA researchers (see Olsen, et al (1983)) have found disappointing performances of ASSPs and FSSPs in a series of tests performed in the NASA/Lewis icing research tunnel. In at least one other case, a JW which was calibrated in the Canadian NRC wet wind tunnel in Ottawa still gave in-flight readings which were judged to be too low by the cognizant scientist (see section 2g) following.

TABLE 3. YEARLY SUMMARY OF CLOUD PHYSICS FLIGHTS ABOVE THE FREEZING LEVEL

Year	No. of Flight Days	S U M M E R	W I N T E R	Flights With Data From:														
				In- side CONUS	Out- side CONUS	JW LWC only	FSSP LWC only	Both JW & FSSP	Max. SLWC (g/m ³)	Ice Particle Counter	PMS 1D-P Probe	PMS 2D-P Probe	Particle Replicator	Ice Xtals	Snow	Graupel	Hail	Freezing Rain
1973	17	17		17		17			3.7									
1974	23	8	15	23				23	.3		23	10	23	23	10			
1975	84	52	32	66	18	16	4	54	2.8	35	35	27	59	59	35	32	8	
1976	167	165	2	141	27	27	30	111	4	92	65	13	157	137	18	103	9	
1977	161	132	29	144	17	42	48	71	3	52	17	5	66	99		59		
1978	285	219	66	248	37	52		214	5	59	74	122	195	242	34	198	38	
1979	344	218	126	275	69	100	3	223	3-6	120	73	107	153	246	54	83	12	
1980	255	162	93	200	55	69	5	181	2-3	115	83	110	167	201	59	35		2
1981	264	183	81	182	82	39	1	224	6	17	115	87	118	226	51	72	14	2
1982	118	29	89	76	42	19	4	95	1	34	19	77	29	95	35	29		
1983	199	66	133	140	59	26		173	4	38	66	106	50	178	104	93	7	
1984	227	92	135	165	62	58	41	128	2	23	57	78	91	172	79	51	5	2
TOTALS	2144	1343	801	1677	467	465	136	1497	---	585	627	742	1108	1678	479	755	93	6

Assessment of Data for Snow

The reader is reminded here that the present study is in response to some practical needs of the FAA and the aviation industry in the area of aircraft icing and therefore the approach and the following considerations reflect that viewpoint.

Although snow does not seem to contribute to ice accretion on smooth aircraft surfaces, it may accumulate in some areas of engine inlet systems and can clog foreign object screens or air filter screens used to protect some engine inlets, especially on helicopters. The principal offending characteristics of snow particles are their relatively large masses and their tendency to pack together at an accumulation point. For the present purposes then, "snow" is defined to include any crystal-like particle or dendrite or porous aggregation of particles, including graupel, and having a diameter larger than 0.3 mm. Table 3 shows that 60% (or about 1235 flights) out of the total appear to have measurements of some kind in snow or graupel. It is probable that some of the other measurements presently classified under "ice crystals" will also qualify as snow.

As listed in Table 3, there are basically four types of airborne instruments for observing individual snow particles. Ice particle "counters" give no information on particle size and therefore are of no use for the present application, except perhaps to help verify the presence of ice particles and to verify the overall counting accuracy of other probes. The PMS 1D-P probes provide a count of particles in a range of discrete size intervals while the 2D-P probes and replicators provide additional information on particle shapes. Table 3 shows that there are over 1100 flights that carried one or more of these size-indicating probes.

From the above statistics it is reasonable to conclude that an adequate number of airborne measurements already exist for use in characterizing snow particle size or mass populations at flight levels. There will be unavoidable uncertainties in relating one- or two-dimensional size measurements to three dimensional masses, however, and these problems are outlined below.

A brief description of the four types of snow-measuring instruments is as follows.

The ice particle counters are usually based on a relatively simple optical system using a polarized light beam which can discriminate between frozen and liquid particles larger than about 0.1 mm. They can count ice and snow crystals or particles but give no information about particle sizes.

The PMS 1D-P probe is an automated size spectrometer for any kind of particles with dimensions in the range of about 0.3 to 4.5 mm. It tallies the number of particles according to the width of the shadow cast across a row of photodiodes as the particle transits a small section of a laser beam exposed to the free airstream ahead of the probe housing. If the projected length of the particle along the row of photodiodes is between 0.3 and 4.5 mm, then the particle is registered correspondingly in one of 15 uniformly wide size intervals which together span the 0.3-4.5 mm range. The principal disadvantage of this instrument is its inability to determine

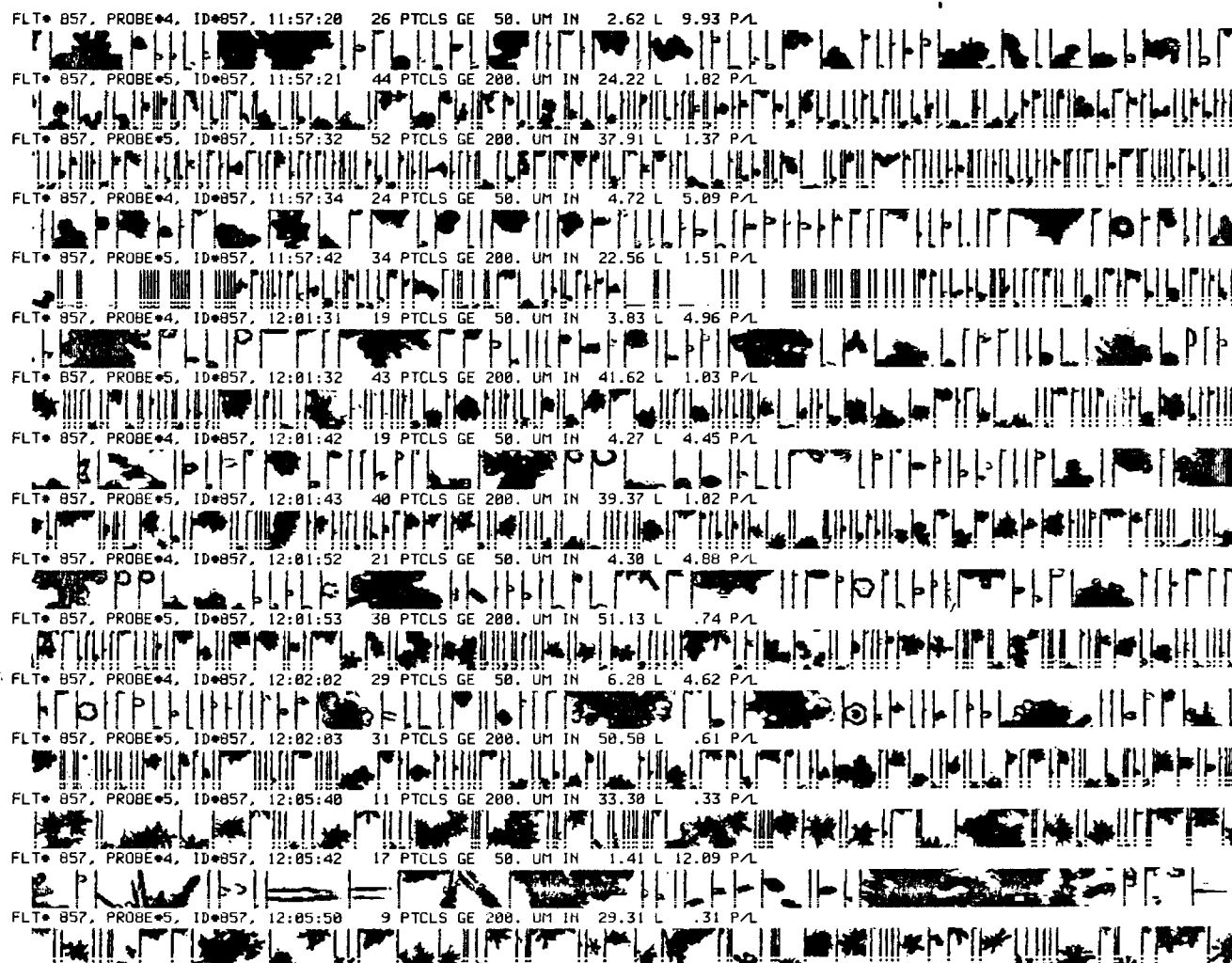


FIGURE 1. SAMPLE OF PARTICLE IMAGERY FROM THE PMS 2D-P PROBE.

For example, the 1D-P data could be used at face value to compute coarse size and mass distributions assuming that all particles were simple disc-shaped crystals. A disc is similar to most snow particle shapes and it is also intermediate between the most extreme shapes--needles on the one hand, and spheres on the other. Besides, differences between the shapes of particles contributing to a given size interval are not as important as the size interval itself. That is, as far as clogging filter screens or accumulating in engine inlets is concerned, a knowledge of the number of particles with dimensions of the order of 4 mm versus those of only 0.4 mm is more important than the particle shapes in either case. Of course, if auxiliary observations of predominant particle shapes were available too, then this information could be used to refine the analyses, if such refinements are desirable.

In a similar way, the 2D-P probe data could be used at face value without the complications of pre-classifying particle shapes or trying to reconstruct partial images. Simply equating the measured area of the particle image, regardless of shape or fragmentation, to a disc of some proportional thickness would again permit the computation of coarse but useful size and mass distributions.

Such simplified procedures would significantly reduce computer requirements and would also promise useful results much sooner and at much less expense than if elaborate classification and compensation procedures had to be adapted or developed. It would also have the added advantage of permitting the assimilation of some of the relatively large amount of replicator data that is already analyzed and available. For example, Table 4 shows one of many pages of replicator data already analyzed from the FACE project (Jordan et al (1981)). The column headings show that the particles were categorized into coarse size intervals as well as into coarse classifications by shape, including what the analysts describe as "splash" and "slush". There is also information on temperature and liquid water content at flight level in the cloud. It makes sense to take advantage of these existing analyses if at all possible. Otherwise the data are practically useless for the present application because it would be prohibitively expensive and time consuming to re-analyze the thousands of original exposures, assuming they are still available.

16

DATE: 80/08/15

AVG VW: 1.1 (M/5)

AVG JW: 1.0 (G/M3)

AVG ICF CRYSTALS: 10.8 (7L)

CLOUD/PASS ID: 3/1

RMS Vw: 2.4

SD JW: .7

AVG GRP & SLUSH: 16.2

VOR: 291 DME: 41 # FLARES: 2 AVG T: -11.2

SD VW: 2.2

MAX JW: 2.1

AVG SPLASH: 4.4

MAX VW: 6.0

Splash μL^{-1} $d > 300 \mu\text{m}$	Slush μL^{-1} $d > 300 \mu\text{m}$	Graupel μL^{-1} $300 - 1000 \mu\text{m}$	Graupel μL^{-1} $d > 1000 \mu\text{m}$	Total μL^{-1} Graupel & Slush	Columns μL^{-1}	Stellaris μL^{-1} Plates μL^{-1} $d < 100 \mu\text{m}$	Stellaris μL^{-1} Plates μL^{-1} $d > 100 \mu\text{m}$	Total Vapor Grown Crystals μL^{-1}	T ($^{\circ}\text{C}$)	W (m s^{-1})	JW (g m^{-3})
--	---	--	--	--	-------------------------------	--	--	---	-----------------------------	----------------------------	-----------------------------

SEC	TIME	SPA	SLU	GSM	GLG	TGS	CL	PSM	PLG	IC	T	VW	JW
1	15:58:20	18	3	0	0	3	0	0	0	0	-10.8	4.5	1.6
2	15:58:21	21	5	0	0	5	0	0	0	0	-11.5	.5	1.6
3	15:58:22	6	6	2	0	8	0	0	0	0	-11.9	.6	1.6
4	15:58:23	3	3	2	0	5	0	0	0	0	-11.9	6.0	2.1
5	15:58:24	6	11	1	0	12	0	0	0	0	-11.7	1.6	1.5
6	15:58:25	1	14	4	0	18	0	3	0	3	-11.4	1.6	1.4
7	15:58:26	0	17	4	0	21	0	2	0	2	-11.4	.5	1.0
8	15:58:27	1	13	12	0	25	0	4	0	4	-11.6	1.1	.4
9	15:58:28	1	12	7	2	21	0	3	0	3	-11.6	*****	.4
10	15:58:29	0	10	19	3	32	0	1	0	1	-11.3	.2	.5
11	15:59:30	0	7	13	1	21	0	1	0	1	-10.3	-1.9	.4
12	15:58:31	0	10	9	2	21	0	0	0	0	-10.0	-.2	0.0
13	15:58:32	0	4	12	2	18	0	0	0	0	-9.8	-.9	0.0

Current Status of the NRL/FAA Data Base

1. Conversion to the SAS System at Johns Hopkins APL.

During the present phase of this Data Base project the FAA program management directed that the NRL/FAA Data Base be converted to the remote access computer system at the Johns Hopkins Applied Physics Laboratory (APL). APL is located about half way between Baltimore, Maryland and Washington, DC. The purpose of this conversion was twofold: firstly, to make the Data Base more easily accessible to FAA users, as well as to potential users from science and industry, for example, and secondly to make use of the powerful software provided by the Statistical Analysis System (SAS) resident on the APL computer. During the first phase of the Data Base project, the Data Base was developed on a Hewlett-Packard HP9825 desktop computer at NRL. Although copies of the Data Base could be provided on standard 9-track computer tape, it was more practical to perform the required data analyses on the HP9825 where the analysis programs had already been developed by NRL. As the project moved into the second phase of acquiring much more data at all altitudes over CONUS, and eventually from foreign sources as well, it appeared prudent to make use of a large, remote access computer for the reasons mentioned above.

The APL computer was chosen in particular because of the availability of the SAS software, whose capabilities the FAA program manager was familiar with, and because transitional help was available through the Federal Computer Performance Evaluation and Simulation Center (FEDSIM) which has experience with SAS.

SAS is a commercial software system marketed by the SAS Institute, Inc., of Cary, North Carolina. SAS consists of several products that provide tools for data entry, data management, and data analysis. It is very "user friendly" and in addition to its main function of providing a wide variety of statistical analysis programs, it makes the users' job of data handling, graphics, and printed tabulations very easy.

The procedure during this second phase of the Data Base project has been to route available flight-data tapes to FEDSIM personnel who have been devising procedures for decoding the variety of original tapes and establishing them as uniformly coded data sets for use with SAS.

2. Flight Data Reviewed for Entry into the NRL/FAA Data Base.

The flight data incorporated into the Data Base during the first phase of the project are listed in an appendix of a previous report by Jeck (1983). Since that time, the additional flight data that have been examined for incorporation into the Data Base are as follows.

a) NACA Rotating Multicylinder Data from Altitudes Above 10,000 Ft.

About 4000 miles of measurements are available from NACA flights over CONUS during the period 1946-1950. About 3200 miles of these data were from flights below 10,000 feet AGL and these were entered into the Data Base during the first phase of the project. The remaining 800 miles from altitudes above 10,000 ft. were added to the Data Base during the present

phase. The maximum liquid water content indicated from any of the NACA flights is 1.9 g/m^3 at -15°C and 10,400 ft. AGL in Cu or Cb clouds over western Oregon in April of 1946.

b) L.A.M.P. Data from the PEP Project in Spain.

Some 190 miles of data from the Precipitation Enhancement Project (PEP) of 1979 had been previously entered into the Data Base. The greatest indicated SLWC from PEP-79 was 1.7 g/m^3 .

Recently, an additional 250 miles of data from PEP-81 has been added, in which the maximum SLWC was 2.0 g/m^3 in Cu clouds at -1°C and 5600 Ft. AGL.

c) The NEWS Project in the Northeastern U.S.

The New England Winter Storms (NEWS) project is a field study of large scale cyclonic storms affecting the northeastern United States. An instrumented aircraft from NCAR obtained cloud physics data in the winters of 1982-83 and 1983-84. The principal investigator is Prof. R. E. Passarelli of MIT. Data from the nine flights of the 1982-83 season have been obtained from NCAR and are in the process of being added to the Data Base. The clouds encountered are mostly stratiform types having SLWCs generally less than about 0.2 g/m^3 .

d) University of Washington Projects.

Magnetic tapes of data have been received recently from 16 flights over the past five years. The particular flights selected were those which seemed to contain the most severe icing encounters and/or the largest SLWCs, as judged from a careful reading of the flight notes from several dozen flights (see Appendix B).

Data from two of these flights have been examined in detail but have not been entered into the Data Base because of some serious discrepancies between indicated LWC from the JW and FSSP probes. In both cases (Flight 724, Feb. 26, 1979, and Flight 1104, July 7, 1983) the JW probe frequently, but not always, indicated LWCs a factor of two or more greater than LWCs computed from the FSSP droplet size spectra. The problem is especially acute when the JW indicates LWCs greater than about 1 g/m^3 . In both flights the JW indicated SLWCs up to 2 g/m^3 , but it is not yet known whether these results are reliable. Twice during Flight 742 the JW SLWCs of 2 g/m^3 , or so, were equal or greater than the theoretical adiabatic limit for LWC at the temperature and flight level at the time. This result strongly implies that the JW may be overestimating the LWCs.

None of the University of Washington data is being entered into the Data Base pending further study of these discrepancies.

e) University of Wyoming Data from CCOPE-1981.

A magnetic tape of data from a CCOPE project flight of June 12, 1981 was obtained for evaluation. As with most of the previous data from University of Wyoming flights, there seemed to be good agreement between the LWCs obtained from the JW and FSSP. The maximum SLWC on this one flight was about 1.5 g/m^3 at -12°C and 19,000 ft. The results from this flight are being added to the Data Base. Only a dozen short penetrations of clouds occurred on this flight, however.

Data from 26 more flights have been ordered and received from the CCOPE project archives at the Bureau of Reclamation in Denver. These have now been entered by FEDSIM into the APL computer as SAS data sets and are being processed into events for the NRL/FAA Data Base.

f) NCAR/SDSM&T Data from CCOPE-1981.

Researchers at NCAR have used the T-28 research aircraft from SDSM&T to obtain cloud physics data in hailstorms. The surface of the T-28 has been "armored" to protect it from damage by hailstones during flight. For this reason, the T-28 has been able to obtain cloud physics data from interior regions of severe storms where other research aircraft have been unable to fly.

A magnetic tape of T-28 data from a CCOPE project flight of Aug. 2, 1981 was obtained for evaluation. The JW probe used on the T-28 has been checked for calibration accuracy in the wet wind tunnel of the Canadian AES (see Strapp and Schemenauer (1982)). The tests showed that the LWCs indicated by this JW were about 37% too low so that a correction factor of 1.58 was needed. The actual data printouts for the August 2 flight revealed a rather erratic behavior for the JW, with occasional excursions to large positive and negative values of LWC. Obviously the negative excursions are erroneous and further study of the data tape and flight notes will be needed to determine the reliability of these data.

g) NCAR/SDSM&T Data from SESAME-1979.

Printouts of data from the T-28 aircraft have been obtained for six flights from the SESAME project during May and June of 1979. An initial examination of these printouts show the occurrence of some serious discrepancies between LWCs indicated by the JW and the FSSP. For LWCs less than about 1 g/m^3 there was usually reasonable agreement, but for larger LWCs there was often a difference of 0.5 to 1 g/m^3 with the FSSP indicating the greater value, even after the JW correction factor was applied. On some flights the JW was inoperative because the sensing wire had been broken by hailstones. In some cases, the LWC values momentarily ranged up to 4.5 g/m^3 and even 6 g/m^3 on the FSSP, but it is not known yet whether those values are reliable.

These data from the SESAME project have not been added to the Data Base pending further inquiry into the reliability of the FSSP data and/or further calibration checks of the JW probe.

h) NASA/NOAA Data from MASEX-1983.

Data tapes from four flights in cold-air stratocumulus clouds over the Atlantic Ocean near New Jersey in January, 1983, have been obtained from the NASA/Goddard Laboratory for Atmospheric Science. The flights were made by a NOAA P-3 research aircraft. The tapes have been added by FEDSIM into the SAS data set library. Very low values of LWC (less than 0.1 g/m^3) were indicated by the JW and frequently erratic and questionable data were recorded from the FSSP. A lengthy investigation, including several consultations with principal scientists on the project, finally concluded that the FSSP data were generally erroneous and unusable for these flights. The LWCs indicated by the JW remain suspiciously low in magnitude and, lacking the FSSP data for comparison, are presently judged to be unreliable for use in the NRL/FAA Data Base.

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APPENDIX A

SUMMARIES OF DATA AVAILABILITY BY PROJECT AND PARTICIPATING AIRCRAFT

The following pages give summary information about the quantity, quality, and availability of cloud physics data from individual aircraft participating in most of the principal cloud physics projects during the past ten years.

Projects are presented in reverse chronological order, and the summary for each participating aircraft is given in a separate form, two forms to a page. Each project had one or more participating aircraft.

The emphasis is on airborne measurements of supercooled liquid water content (SLWC), droplet size spectra, and solid particles above the freezing level in clouds. The projects included are primarily those carried out in the United States and Canada, or by U. S. research aircraft participating in international projects. There may be other projects that are not included because the author was either unaware of them or no information has been located for them yet. The author welcomes any additional information on flights or projects that may have been overlooked.

When reading the summaries, it will be helpful to keep the following notes in mind.

Some locations and many agencies and institutions are indicated by acronyms or abbreviations. The reader is referred to the list of "ABBREVIATIONS" in this report for the meaning of these symbols. In addition, there is a list of "ADDRESSES OF PROJECT PARTICIPANTS" to further identify participants, principal investigators, and data custodians.

Note on "Number of Flights". The numerical entries give the apparent number of separate days that successful flights took place with at least some passes in clouds at altitudes above the freezing level. In each project there were often additional flights that are not listed here. These include test or ferry flights, tower fly-bys, clear air soundings, aerosol sampling flights outside of clouds, flights below cloud base, above cloud top, or entirely below the freezing level, or flights which produced only erroneous data.

Note on "Estimated Value of Flights for...SLWC, etc.". Entries for Estimated Maximum SLWC are given only if such information was available. Entries for the value of the flights for snow, etc., are sometimes educated guesses, but a question mark "?" is entered when there was not even enough information available for that. More exact information would require access to the flight notes or to the actual data.

Note on "Data Custodian". Prospective users should, of course, be sensitive to the priorities and workloads of the custodian, especially if the custodian is an individual researcher. Almost all of the projects were supported by public funds and therefore, in principle, the data should be

made available upon request. Generally there will be a nominal expense involved for computer time and services required to provide copies of the original data tapes, charts, etc. Cases where substantial expense may be involved to prepare data tapes for use by outside customers are noted explicitly on the summary sheets.

Project: TRIP* (1984)

*Thunderstorm Research International Program

Date(s): July, Aug., 1984

Location(s): New Mexico

Participating Aircraft: NCAR/NOAA (Schweizer 2-32 Sailplane)

Number of Flights: 12

Estimated Value of Flights for data on:

Supercooled LWC	Good	Est. Max SLWC: 2 g/m ³
Snow	---	
Ice Particles	OK	
Graupel	OK	
Hail	---	
Rain	---	
Freezing Rain or Drizzle	---	

Cloud Physics Probes in Use:

JW LWC Meter	(1-45 μ m)	Yes
PMS FSSP	(3-45 ")	Yes
PMS 1D-C (200X)	(20-300 ")	No
PMS 2D-C	(25-800 ")	No
PMS 1D-P (200Y)	(0.3-4.5 mm)	No
PMS 2D-P	(0.2-6.4 mm)	No
Ice Particle Counter		No
Particle Replicator ("Cannon" camera)		Yes
Icing Rate Meter		No

Cloud Types Sampled: Cu, Cb

Altitude Range for Data: 11-27 k ft (3.5-8 km) ASL

Data Custodian: NCAR Convective Storms Division, Boulder, Colorado

Remarks:

Project: TRIP (1984)

Date(s): July, Aug., 1984

Location(s): New Mexico

Participating Aircraft: New Mexico Tech. (powered sailplane)

Number of Flights: 17

Estimated Value of Flights for data on:

Supercooled LWC	OK (See note 2)	Est. Max SLWC: ?
Snow	---	
Ice Particles	Some	
Graupel	?	
Hail	---	
Rain	---	
Freezing Rain or Drizzle	---	

Cloud Physics Probes in Use:

JW LWC Meter	(1-45 μ m)	Yes (See note 1)
PMS FSSP	(3-45 ")	No
PMS 1D-C (200X)	(20-300 ")	No
PMS 2D-C	(25-800 ")	Yes
PMS 1D-P (200Y)	(0.3-4.5 mm)	No
PMS 2D-P	(0.2-6.4 mm)	No
Ice Particle Counter		No
Particle Replicator		No
Icing Rate Meter		No

Cloud Types Sampled:

Altitude Range for Data: 0°C level and higher

Data Custodian: ? Inquire at NCAR Convective Storms Division, Boulder, Colorado

Remarks: 1 - LWC meter was a CSIRO-King type.

2 - No FSSP available for droplet sizes or LWC comparison.

Project: NOAA/NORTH DAKOTA Cooperative Program (1984)

Date(s): June, July, 1984

Location(s): North Dakota

Participating Aircraft: Univ. North Dakota (Cessna "Citation II")

Number of Flights: 10

Estimated Value of Flights for data on:

Supercooled LWC	OK	Est. Max SLWC: 1.8 g m^{-3}
Snow	OK	
Ice Particles	OK	
Graupel	OK	
Hail	---	
Rain	OK	
Freezing Rain or Drizzle	---	

Cloud Physics Probes in Use:

JW LWC Meter	(1-45 μm)	Yes
PMS FSSP	(3-45 ")	Yes
PMS 1D-C (200X)	(20-300 ")	No
PMS 2D-C	(25-800 ")	Yes
PMS 1D-P (200Y)	(0.3-4.5 mm)	Yes
PMS 2D-P	(0.2-6.4 mm)	No
Ice Particle Counter		No
Particle Replicator		No
Icing Rate Meter		Yes

Cloud Types Sampled: Cb, Cu

Altitude Range for Data: 8-35 k ft (2.5 - 10.5 km)

Data Custodian: Univ. North Dakota, Grand Forks, ND

Remarks:

Project: MIZEX (1984)

*Marginal Ice Zone Experiment

Date(s): June, July, 1984

Location(s): Greenland and Greenland Sea

Participating Aircraft: German Aerospace Research Estab. (DFVLR)(Falcon-20Jet)

Number of Flights: 13

Estimated Value of Flights for data on:

Supercooled LWC	?	Est. Max SLWC: ?
Snow	---	
Ice Particles	?	
Graupel	---	
Hail	---	
Rain	---	
Freezing Rain or Drizzle	---	

Cloud Physics Probes in Use:

LWC Meter	(1-45 μm)	Yes (CSIRO "King" LWC probe)
PMS FSSP	(3-45 ")	Yes
PMS 1D-C (200X)	(20-300 ")	?
PMS 2D-C	(25-800 ")	?
PMS 1D-P (200Y)	(0.3-4.5 mm)	?
PMS 2D-P	(0.2-6.4 mm)	?
Ice Particle Counter		?
Particle Replicator		?
Icing Rate Meter		?

Cloud Types Sampled: St, Sc

Altitude Range for Data: ?

Data Custodian: DFVLR

Remarks: "King" probe reportedly underestimates seriously the peak values of LWC; FSSP data are missing for at least one flight.

Reference: Ogren et al (1985)

Project: AIMCS* (1984)

*Airborne Investigation of Mesoscale Convective Systems

Date(s): June-July, 1984

Location(s): OK, CO, WY

Participating Aircraft: NOAA (Lockheed WP-3A "Orion")

Number of Flights: 6

Estimated Value of Flights for data on:

Supercooled LWC	OK (See note 1) Est. Max SLWC: ?g/m ³
Snow	---
Ice Particles	?
Graupel	?
Hail	?
Rain	OK
Freezing Rain or Drizzle	---

Cloud Physics Probes in Use:

JW LWC Meter	(1-45 μ m)	Yes
PMS FSSP or ASSP	(3-45 ")	No (See note 1)
PMS 1D-C (200X)	(20-300 ")	No
PMS 2D-C	(25-800 ")	Yes
PMS 1D-P (200Y)	(0.3-4.5 mm)	No
PMS 2D-P	(0.2-6.4 mm)	Yes
Ice Particle Counter		No
Particle Replicator		?
Icing Rate Meter		No

Cloud Types Sampled: Cb

Altitude Range for Data: ?

Data Custodian: NOAA/ERL, Boulder, Colorado. (John B. Cuning,
Principal Investigator)

Remarks: 1 -- No FSSP available for LWC comparisons.

Project: MAYPOLE*-II (1984)

*CP-2 (Radar) Multi-Parameter Measurements

Date(s): May, June, 1984

Location(s): Colorado

Participating Aircraft: NCAR/UWY (Beechcraft BE-200T "King Air")

Number of Flights: 20

Estimated Value of Flights for data on:

Supercooled LWC	OK (See note 1) Est. Max SLWC: ?
Snow	?
Ice Particles	OK
Graupel	OK
Hail	---
Rain	?
Freezing Rain or Drizzle	---

Cloud Physics Probes in Use:

JW LWC Meter	(1-45 μ m)	Yes and CSIRO-King probe
PMS FSSP	(3-45 ")	No
PMS 1D-C (200X)	(20-300 ")	No
PMS 2D-C	(25-800 ")	Yes (See note 2)
PMS 1D-P (200Y)	(0.3-4.5 mm)	No
PMS 2D-P	(0.2-6.4 mm)	Yes (See note 2)
Ice Particle Counter		?
Particle Replicator		No
Icing Rate Meter		?

Cloud Types Sampled: ?

Altitude Range for Data: ?

Data Custodian: NCAR Research Aviation Facility, Boulder, Colorado

Remarks: 1 - No FSSP for droplet sizes or LWC comparison.

2 - A pair of 2D-C probes was used on one wing and a pair of 2D-P probes were used on the other wing. In each pair, one probe had the laser beam oriented vertically and the other probe had the beam horizontal.

Project: Maypole II (1984)

Date(s): June, 1984

Location(s): Colorado

Participating Aircraft: SDSM&T (North American, T-28)

Number of Flights: 5

Estimated Value of Flights for data on:

Supercooled LWC	OK	Est. Max SLWC: 1 g/m ³
Snow	---	
Ice Particles	OK	
Graupel	OK	
Hail	OK	
Rain	?	
Freezing Rain or Drizzle	---	

Cloud Physics Probes in Use:

JW LWC Meter	(1-45 μ m)	Yes
PMS FSSP	(3-45 ")	Yes
PMS 1D-C (200X)	(20-300 ")	No
PMS 2D-C	(25-800 ")	Yes
PMS 1D-P (200Y)	(0.3-4.5 mm)	No
PMS 2D-P	(0.2-6.4 mm)	Yes
Ice Particle Counter		No
Particle Replicator		Yes
Icing Rate Meter		No
Hail Spectrometer		Yes

Cloud Types Sampled: Cb

Altitude Range for Data: 12-18 k ft (3.8 - 5.8 km) ASL

Data Custodian: SDSM&T and NCAR/CSD

Remarks:

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Project: ER-2 Thunderstorm Studies (1984)

Date(s): May, 1984

Location(s): Kansas

Participating Aircraft: Univ. North Dakota (Cessna Citation II")

Number of Flights: 2

Estimated Value of Flights for data on:

Supercooled LWC	OK	Est. Max SLWC: 0.2 g/m ³
Snow	---	
Ice Particles	OK	
Graupel	---	
Hail	---	
Rain	---	
Freezing Rain or Drizzle	---	

Cloud Physics Probes in Use:

JW LWC Meter	(1-45 μ m)	Yes
PMS FSSP	(3-45 ")	Yes
PMS 1D-C (200X)	(20-300 ")	No
PMS 2D-C	(25-800 ")	Yes
PMS 1D-P (200Y)	(0.3-4.5 mm)	Yes
PMS 2D-P	(0.2-6.4 mm)	No
Ice Particle Counter	(100 m)	No
Particle Replicator		No
Icing Rate Meter		Yes

Cloud Types Sampled: Ci, Ac

Altitude Range for Data: 18-41 k ft (5.5 - 12.5 km)

Data Custodian: Univ. North Dakota, Grand Forks, ND

Remarks: Project sponsored by NASA/GSFC.

Project: ARC* Snowpack Project (1984)

*Alberta Research Council

Date(s): Feb., 1984

Location(s): Alberta Province, Canada (mountains)

Participating Aircraft: INTERA/ARC (Cessna 441 "Conquest")

Number of Flights: 8

Estimated Value of Flights for data on:

Supercooled LWC	OK	Est. Max SLWC: 0.5 g/m ³
Snow	OK	
Ice Particles	Good	
Graupel	?	
Hail	---	
Rain	---	
Freezing Rain or Drizzle	---	

Cloud Physics Probes in Use:

JW LWC Meter	(1-45 μ m)	Yes
PMS FSSP	(3-45 ")	Yes
PMS 1D-C (200X)	(20-300 ")	No
PMS 2D-C	(25-800 ")	Yes
PMS 1D-P (200Y)	(0.3-4.5 mm)	No
PMS 2D-P	(0.2-6.4 mm)	Yes
Ice Particle Counter		No
Particle Replicator		No
Icing Rate Meter		No

Cloud Types Sampled: Orographic and Cu, Ac

Altitude Range for Data: 11 to 20 k ft. (3-6 km) ASL

Data Custodian: Alberta Research Council, Edmonton, Alberta, Canada

Remarks:

Project: NASA Icing Flights (1984)

Date(s): Jan. - May, 1984

Location(s): Great Lakes Vicinity

Participating Aircraft: NASA/Lewis (DeHavilland DHC-6 "Twin Otter")

Number of Flights: 19

Estimated Value of Flights for data on:

Supercooled LWC	Good	Est Max. SLWC: 1.2 g/m ³
Snow	----	
Ice Particles	----	
Graupel	----	
Hail	----	
Rain	----	
Freezing Rain or Drizzle	----	

Cloud Physics Probes in Use:

JW LWC Meter	(1-45 μ m)	Yes
PMS FSSP	(3-45 ")	Yes
PMS 1D-C (200X)	(20-300 ")	Yes
PMS 2D-C	(25-800 ")	No
PMS 1D-P (200Y)	(0.3-4.5 mm)	No
PMS 2D-P	(0.2-6.4 mm)	No
Ice Particle Counter		No
Particle Replicator	(Soot Slide)	Yes
Icing Rate Meter		Yes
Rotating Multicylinders		Yes

Cloud Types Sampled: St, Sc

Altitude Range for Data: 3-11 k ft (1-3.5 km)

Data Custodian: NASA/Lewis Research Center, Cleveland, Ohio
(Robert F. Ide, principal investigator)

Remarks:

Project: SCPP* (1983-84)

*Sierra Cooperative Pilot Project

Date(s): Jan. - Mar., 1984

Location(s): California (Windward Sierra Mountains)

Participating Aircraft: Univ. Wyoming (Beechcraft B-200T "King Air")

Number of Flights: 14

Estimated Value of Flights for data on:

Supercooled LWC	Good	Est Max SLWC: 1-2 g/m ³
Snow	?	
Ice Particles	Good	
Graupel	?	
Hail	---	
Rain	---	
Freezing rain or drizzle	---	

Cloud Physics Probes in Use:

JW LWC Meter	(1-45 μ m)	Yes	and CSIRO-King probe
PMS FSSP	(3-45 ")	Yes	
PMS 1D-C (200X)	(20-300 ")	Yes	
PMS 2D-C	(25-800 ")	Yes	
PMS 1D-P (200Y)	(0.3-4.5 mm)	No	
PMS 2D-P	(0.2-6.4 mm)	Yes	
Ice Particle Counter		No	
Particle Replicator		Yes	
Icing Rate Meter		Yes	

Cloud Types Sampled: St, Sc, orographic
 Altitude Range for Data: 0-18 k ft (0-5.5 km)
 Data Custodian: Bureau of Reclamation, Denver, Colorado

Remarks:

Project: SCPP* (1983-84)

*Sierra Cooperative Pilot Project

Date(s): Jan. - Mar., 1984

Location(s): California (Windward Sierra Mountains)

Participating Aircraft: Univ. North Dakota (Piper "Cheyenne II")

Number of Flights: 15

Estimated Value of Flights for data on:

Supercooled LWC	OK	Est Max. SLWC: < 1 g/m ³
Snow	---	
Ice Particles	OK	
Graupel	---	
Hail	---	
Rain	---	
Freezing rain or drizzle	---	

Cloud Physics Probes in Use:

JW LWC Meter	(1-45 μ m)	Yes
PMS FSSP or ASSP	(3-45 ")	No
PMS 1D-C (200X)	(20-300 ")	No
PMS 2D-C	(25-800 ")	No
PMS 1D-P (200Y)	(0.3-4.5 mm)	No
PMS 2D-P	(0.2-6.4 mm)	No
Ice Particle Counter	(>100 μ m)	Yes
Particle Replicator		No
Icing Rate Meter		Yes

Cloud Types Sampled: St, Sc, orographic
 Altitude Range for Data: 0-16 k ft (0-5 km)
 Data Custodian: Bureau of Reclamation, Denver, Colorado

Remarks: This aircraft was used primarily for cloud seeding purposes rather than for cloud physics.

Project: Chinook Helicopter Icing Trials (1984)

Date(s): Jan.-March, 1984

Location(s): Nova Scotia, Canada

Participating Aircraft: Boeing Vertol (RAF HC, Mk1, "Chinook")

Number of Flights: 41

Estimated Value of Flights for data on:

Supercooled LWC	OK (See note 1)	Est. Max SLWC: 1 g/m ³
Snow	Fair (See note 2)	
Ice Particles	Fair (See note 3)	
Graupel	?	
Hail	---	
Rain	?	
Freezing Rain or Drizzle	OK	

Cloud Physics Probes in Use:

JW LWC Meter	(1-45 μ m)	No (See note 1)
PMS FSSP	(3-45 ")	Yes (See note 3)
PMS 1D-C (200X)	(20-300 ")	Yes (See note 3)
PMS 2D-C	(25-800 ")	No
PMS 1D-P (200Y)	(0.3-4.5 mm)	No
PMS 2D-P	(0.2-6.4 mm)	No
Ice Particle Counter		No
Particle Replicator ("soot gun")		Yes
Icing Rate Meter		Yes (See note 1)

Cloud Types Sampled: St, Sc

Altitude Range for Data: 1.5 - 10k ft. (.5-3km) ASL

Data Custodian: Unknown; contact Manager of Experimental Operation,
Boeing Vertol Company, P.O. Box 16858, Philadelphia,
PA 19142

Remarks: 1 - LWC was determined from icing rate meters.

2 - Only a one-dimensional particle size spectrum up to
300 μ m diameter was available--no two-dimensional
imaging.

3 - Both PMS probes suffered from calibration and
operational problems.

References: Toler (1984), Lunn et al (1984)

Project: Cloud Chemistry (1984)

Date(s): Jan. - Feb., 1984

Location(s): Washington State

Participating Aircraft: Univ. Washington (Douglas B-23)

Number of Flights: 4

Estimated Value of Flights for data on:

Supercooled LWC	Good	Est. Max SLWC: 1 g/m ³
Snow	Fair	
Ice Particles	Fair	
Graupel	Fair	
Hail	---	
Rain	Fair	
Freezing Rain or Drizzle	---	

Cloud Physics Probes in Use:

JW LWC Meter	(1-45 μ m)	Yes
PMS FSSP	(3-45 ")	Yes (See Note 1)
PMS 1D-C (200X)	(20-300 ")	Yes
PMS 2D-C	(25-800 ")	Yes
PMS 1D-P (200Y)	(0.3-4.5 mm)	Yes
PMS 2D-P	(0.2-6.4 mm)	Yes
Ice Particle Counter		Yes
Particle Replicator		No
Icing Rate Meter		No

Cloud Types Sampled: Sc, Cu, Orographic Sc and Cu.

Altitude Range for Data: 2-10 k ft. (.6-3 km) ASL

Data Custodian: Univ. Washington, Seattle, WA

Remarks: 1 - No strobes or probe activity rates recorded.

Project: NASA-CAR* Flights (1984)

*Cloud Absorption Radiometer

Date(s): Jan., 1984

Location(s): Washington State

Participating Aircraft: Univ. Washington (Douglas B-23)

Number of Flights: 4

Estimated Value of Flights for data on:

Supercooled LWC	Good	Est. Max SLWC: 1 g/m ³
Snow	Fair	
Ice Particles	---	
Graupel	Fair	
Hail	---	
Rain	---	
Freezing Rain or Drizzle	---	

Cloud Physics Probes in Use:

JW LWC Meter	(1-45 μ m)	Yes
PMS FSSP	(3-45 ")	Yes (See Note 1)
PMS 1D-C (200X)	(20-300 ")	Yes
PMS 2D-C	(25-800 ")	Yes
PMS 1D-P (200Y)	(0.3-4.5 mm)	Yes
PMS 2D-P	(0.2-6.4 mm)	Yes
Ice Particle Counter		Yes
Particle Replicator		No
Icing Rate Meter		No

Cloud Types Sampled: Sc, St
Altitude Range for Data: 2-6 k ft. (.6-2 km) ASL
Data Custodian: Univ. Washington, Seattle, WA

Remarks: 1 - No strobes or probe activity rates recorded.

Project: Univ. Chicago Lake-Effect Snow Project (1983-84)

Date(s): Dec. 1983 - Jan., 1984

Location(s): Lake Michigan vicinity

Participating Aircraft: NCAR/UWY (Beechcraft BE-200T "King Air")

Number of Flights: 17

Estimated Value of Flights for data on:

Supercooled LWC	Good	Est. Max SLWC: ?
Snow	Good	
Ice Particles	Good	
Graupel	?	
Hail	---	
Rain	---	
Freezing Rain or Drizzle	---	

Cloud Physics Probes in Use:

JW LWC Meter (1-45 μ m)	Yes	(and PMS/CSIRO-King)
PMS FSSP (3-45 ")	Yes	
PMS 1D-C (200X) (20-300 ")	No	
PMS 2D-C (25-800 ")	Yes	
PMS 1D-P (200Y) (0.3-4.5 mm)	Yes	
PMS 2D-P (0.2-6.4 mm)	Yes	
Ice Particle Counter	No	
Particle Replicator	No	
Icing Rate Meter	Yes	

Cloud Types Sampled: St, Sc

Altitude Range for Data: Up to 12 k ft. (3.5 km) ASL

Data Custodian: NCAR Research Aviation Facility, Boulder, Colorado.
(Principal Investigator: Prof. R. R. Braham, Univ.
Chicago, Chicago, Illinois 60637)

Remarks:

Project: Univ. Chicago Lake-Effect Snow Project (1983-84)

Date(s): Dec. 1983 - Jan., 1984

Location(s): Lake Michigan vicinity

Participating Aircraft: NCAR (Beechcraft BE-80 "Queen Air")

Number of Flights: 20

Estimated Value of Flights for data on:

Supercooled LWC	Good	Est. Max SLWC: ?
Snow	OK	(See note 1)
Ice Particles	OK	(See note 1)
Graupel	?	
Hail	---	
Rain	---	
Freezing Rain or Drizzle	---	

Cloud Physics Probes in Use:

JW LWC Meter (1-45 μ m)	Yes
PMS FSSP (3-45 ")	Yes
PMS 1D-C (200X) (20-300 ")	No
PMS 2D-C (25-800 ")	No
PMS 1D-P (200Y) (0.3-4.5 mm)	Yes (See Note 1)
PMS 2D-P (0.2-6.4 mm)	No
Ice Particle Counter	No
Particle Replicator	No
Icing Rate Meter	Yes

Cloud Types Sampled: St, Sc

Altitude Range for Data: Up to 12 k ft. (3.5 km) ASL

Data Custodian: NCAR Research Aviation Facility, Boulder, Colorado.
(Principal Investigator: Prof. R. R. Braham, Univ.
Chicago, Chicago, Illinois 60637)

Remarks: 1 - No information available on particle shape

Project: NEWS* (1983)

*New England Winter Storms

Date(s): Nov., Dec., 1983

Location(s): Northeastern United States

Participating Aircraft: NCAR/UWY (Beechcraft BE-200T "King Air")

Number of Flights: 10

Estimated Value of Flights for data on:

Supercooled LWC	OK	Est. Max SLWC: ?
Snow	OK	
Ice Particles	OK	
Graupel	---	
Hail	---	
Rain	?	
Freezing Rain or Drizzle	?	

Cloud Physics Probes in Use:

JW LWC Meter	(1-45 μm)	Yes (and PMS/CSIRO-King)
PMS FSSP	(3-45 ")	Yes
PMS 1D-C (200X)	(20-300 ")	No
PMS 2D-C	(25-800 ")	Yes
PMS 1D-P (200Y)	(0.3-4.5 mm)	Yes
PMS 2D-P	(0.2-6.4 mm)	Yes
Ice Particle Counter		No
Particle Replicator		No
Icing Rate Meter		Yes

Cloud Types Sampled: Ns, St, Sc

Altitude Range for Data: ?

Data Custodian: NCAR Research Aviation Facility, Boulder, Colorado

Remarks: 1 - Principal Investigator: Prof. R. E. Passarelli, Dept. of Meteorology and Physical Oceanography, MIT, Cambridge, MA, 02139

Project: NOAA/HRD Hurricane Flights (1983)

Date(s): Aug. - Oct. 1983

Location(s): W. Atlantic, Gulf of Mexico, E. Pacific

Participating Aircraft: NOAA (Lockheed WP-3D)

Number of Flights: 1 (with cloud data above the 0°C level)
12 (with cloud data below the 0°C level)

Estimated Value of Flights for data on:

Supercooled LWC	Fair	Est. Max SLWC:
Snow	---	
Ice Particles	?	
Graupel	?	
Hail	---	
Rain	?	
Freezing Rain or Drizzle	---	

Cloud Physics Probes in Use:

JW LWC Meter	(1-45 μm)	Yes
PMS FSSP	(3-45 ")	Yes (See note 1)
PMS 1D-C (200X)	(20-300 ")	No
PMS 2D-C	(25-800 ")	Yes
PMS 1D-P (200Y)	(0.3-4.5 mm)	No
PMS 2D-P	(0.2-6.4 mm)	Yes
Ice Particle Counter		No
Particle Replicator		No
Icing Rate Meter		No

Cloud Types Sampled: Hurricanes, tropical storms

Altitude Range for Data: 0.3 - 25 k ft (0.1-7.5 km)

Data Custodian: NOAA/AOML/HRD, Miami, Florida

Remarks: 1 - No strobes or probe activity rates are available.

Reference: Friedman et al (1984)

Project: Cloud Chemistry (1983)

Date(s): Aug., Sept., and Nov., 1983

Location(s): Washington State

Participating Aircraft: Univ. Washington (Douglas B-23)

Number of Flights: 5

Estimated Value of Flights for data on:

Supercooled LWC	Good	Est. Max SLWC: 2 g/m ³
Snow	Fair	
Ice Particles	---	
Graupel	---	
Hail	---	
Rain	Some	
Freezing Rain or Drizzle	---	

Cloud Physics Probes in Use:

JW LWC Meter	(1-45 μ m)	Yes
PMS FSSP	(3-45 ")	Yes (See Note 1)
PMS 1D-C (200X)	(20-300 ")	Yes
PMS 2D-C	(25-800 ")	Yes
PMS 1D-P (200Y)	(0.3-4.5 mm)	Yes
PMS 2D-P	(0.2-6.4 mm)	Yes
Ice Particle Counter		Yes
Particle Replicator		No
Icing Rate Meter		No

Cloud Types Sampled: Oro Cu, Cu, St, Sc, Ns
 Altitude Range for Data: 3-14k ft. (1-4 km) ASL
 Data Custodian: Univ. Washington, Seattle, WA

Remarks: 1 - No strobes or probe activity rates recorded.

Project: GROSSVERSUCH IV (1983)

Date(s): June - July, 1983

Location(s): Switzerland

Participating Aircraft: SDSM&T (North American, T-28)

Number of Flights: 7

Estimated Value of Flights for data on:

Supercooled LWC	OK	Est. Max SLWC: 1.6 g m ⁻³
Snow	---	
Ice Particles	OK	
Graupel	OK	
Hail	OK	
Rain	---	
Freezing Rain or Drizzle	---	

Cloud Physics Probes in Use:

JW LWC Meter	(1-45 μ m)	Yes
PMS FSSP	(3-45 ")	Yes
PMS 1D-C (200X)	(20-300 ")	No
PMS 2D-C	(25-800 ")	Yes
PMS 1D-P (200Y)	(0.3-4.5 mm)	No
PMS 2D-P	(0.2-6.4 mm)	No
Ice Particle Counter		No
Particle Replicator		Yes
Icing Rate Meter		No
Hail Spectrometer		No

Cloud Types Sampled: Cb
 Altitude Range for Data: to 18 k ft (5.5 km) ASL
 Data Custodian: SDSM&T, Rapid City, SD

Remarks:

Project: NEXRAD* Support Flights (1983)

*NEXT generation RADar

Date(s): June, July, August, 1983

Location(s): Massachusetts

Participating Aircraft: Univ. North Dakota (Cessna "Citation II")

Number of Flights: 13

Estimated Value of Flights for data on:

Supercooled LWC	OK (See note 1)	Est. Max SLWC: 1.5 g/m ³
Snow	OK	
Ice Particles	OK	
Graupel	OK	
Hail	---	
Rain	OK	
Freezing Rain or Drizzle	---	

Cloud Physics Probes in Use:

JW LWC Meter	(1-45 μ m)	Yes
PMS FSSP	(3-45 ")	Yes
PMS 1D-C (200X)	(20-300 ")	No
PMS 2D-C	(25-800 ")	Yes
PMS 1D-P (200Y)	(0.3-4.5 mm)	Yes
PMS 2D-P	(0.2-6.4 mm)	No
Ice Particle Counter	(100 m)	No
Particle Replicator		No
Icing Rate Meter		Yes

Cloud Types Sampled: Cb, St,

Altitude Range for Data: 0-35 k ft (0-10.5 km)

Data Custodian: Univ. North Dakota, Grand Forks, ND

Remarks: 1 - SLWC encountered during about 50% of the flight time.

Reference:

Project: Alberta Hail Project (1983)

Date(s): May-Aug., 1983

Location(s): Alberta Province, Canada

Participating Aircraft: INTERA/ARC (Cessna 441 "Conquest")

Number of Flights: 34

Estimated Value of Flights for data on:

Supercooled LWC	Good	Est. Max SLWC: 2 g/m ³
Snow	?	
Ice Particles	Good	
Graupel	Good	
Hail	---	
Rain	Good	
Freezing Rain or Drizzle	---	

Cloud Physics Probes in Use:

JW LWC Meter	(1-45 μ m)	Yes
PMS FSSP	(3-45 ")	Yes
PMS 1D-C (200X)	(20-300 ")	No
PMS 2D-C	(25-800 ")	Yes
PMS 1D-P (200Y)	(0.3-4.5 mm)	No
PMS 2D-P	(0.2-6.4 mm)	Yes
Ice Particle Counter		No
Particle Replicator		No
Icing Rate Meter		No

Cloud Types Sampled: Cu, Cb

Altitude Range for Data: Up to 20 k ft. (6 km) ASL

Data Custodian: Alberta Research Council, Edmonton, Alberta, Canada

Remarks: "This season was the most operationally successful and scientifically productive season in the history of hail research in Alberta."

Reference: "Alberta Hail Project Field Program 83"

Project: Cumulus Studies (1983)

Date(s): Apr. - May, July - Aug., and Nov., 1983

Location(s): Washington State

Participating Aircraft: Univ. Washington (Douglas B-23)

Number of Flights: 7

Estimated Value of Flights for data on:

Supercooled LWC	Good	Est. Max SLWC: 2 g/m ³
Snow	---	
Ice Particles	Good	
Graupel	Good	
Hail	---	
Rain	Fair	
Freezing Rain or Drizzle	---	

Cloud Physics Probes in Use:

JW LWC Meter	(1-45 μ m)	Yes
PMS FSSP	(3-45 ")	Yes (See note 2)
PMS 1D-C (200X)	(20-300 ")	Yes
PMS 2D-C	(25-800 ")	Yes
PMS 1D-P (200Y)	(0.3-4.5 mm)	Yes
PMS 2D-P	(0.2-6.4 mm)	Yes
Ice Particle Counter		Yes
Particle Replicator		No
Icing Rate Meter		No

Cloud Types Sampled: Cu, Cu Cong, Cb, As, St, Ac, TCu

Altitude Range for Data: 2 - 19 ft. (.6 - 6 km) ASL

Data Custodian: Univ. Washington

Remarks: 1 - Occasional problems with various PMS probes. During Flight 1110 the scientific crew noted airframe icing was more severe than ever seen before.

2 - No strobes or probe activity rates recorded.

Project: ARC* Snowpack Project (1983)

*Alberta Research Council

Date(s): March, Nov., Dec., 1983

Location(s): Alberta Province, Canada (mountains)

Participating Aircraft: INTERA/ARC (Cessna 441 "Conquest")

Number of Flights: 13

Estimated Value of Flights for data on:

Supercooled LWC	OK	Est. Max SLWC: 0.9 g/m ³
Snow	Good	
Ice Particles	Good	
Graupel	?	
Hail	---	
Rain	---	
Freezing Rain or Drizzle	---	

Cloud Physics Probes in Use:

JW LWC Meter	(1-45 μ m)	Yes
PMS FSSP	(3-45 ")	Yes
PMS 1D-C (200X)	(20-300 ")	No
PMS 2D-C	(25-800 ")	Yes
PMS 1D-P (200Y)	(0.3-4.5 mm)	No
PMS 2D-P	(0.2-6.4 mm)	Yes
Ice Particle Counter		No
Particle Replicator		No
Icing Rate Meter		No

Cloud Types Sampled: Orographic and Cu, TCu, Ac, Sc, As, St

Altitude Range for Data: 11-15 k ft. (3-4.5 km) ASL

Data Custodian: Alberta Research Council, Edmonton, Alberta, Canada

Remarks:

Project: MIZEX*-WEST (1983)

*Marginal Ice Zone Experiment

Date(s): Feb., 1983

Location(s): Eastern Bering Sea

Participating Aircraft: NOAA (Lockheed WP-3D)

Number of Flights: 4

Estimated Value of Flights for data on:

Supercooled LWC	OK (See note 1)	Est. Max SLWC: ?
Snow	?	
Ice Particles	?	
Graupel	---	
Hail	---	
Rain	---	
Freezing Rain or Drizzle	---	

Cloud Physics Probes in Use:

JW LWC Meter	(1-45 μ m)	Yes
PMS FSSP	(3-45 ")	Yes (See note 1)
PMS 1D-C (200X)	(20-300 ")	No
PMS 2D-C	(25-800 ")	No
PMS 1D-P (200Y)	(0.3-4.5 mm)	No
PMS 2D-P	(0.2-6.4 mm)	No
Ice Particle Counter		No
Particle Replicator		No
Icing Rate Meter		No

Cloud Types Sampled: Offshore Sc streets; widespread St.
Altitude Range for Data: Mostly below 5 k ft. Maybe some up to
20 k Ft. (6 km) ASL

Data Custodian: NOAA/PMEL, (James Overland, Principal Investigator).

Remarks: 1 - FSSP may be undercounting. No strobes or probe activity
rates are available.

Reference: Overland and Pease (1983)

Project: NASA Icing Flights (1983)

Date(s): Jan. - March, 1983

Location(s): Great Lakes vicinity

Participating Aircraft: NASA/Lewis (DeHavilland DHC-6 "Twin Otter")

Number of Flights: 11

Estimated Value of Flights for data on:

Supercooled LWC	Fair-Good	Est. Max SLWC: 1 g/m ³
Snow	---	
Ice Particles	---	
Graupel	---	
Hail	---	
Rain	---	
Freezing Rain or Drizzle	---	

Cloud Physics Probes in Use:

JW LWC Meter	(1-45 μ m)	Yes
PMS FSSP	(3-45 ")	Yes
PMS 1D-C (200X)	(20-300 ")	Yes
PMS 2D-C	(25-800 ")	No
PMS 1D-P (200Y)	(0.3-4.5 mm)	No
PMS 2D-P	(0.2-6.4 mm)	No
Ice Particle Counter		No
Particle Replicator		Yes
Icing Rate Meter		Yes
Rotating Multicylinders		Yes

Cloud Types Sampled: St, Sc
Altitude Range for Data: 3-9 k ft (1-3 km)
Data Custodian: NASA/Lewis Research Center, Cleveland, Ohio
(Robert F. Ide, principal investigator)

Remarks: Noise problems on JW LWC meter first few flights.

Reference: Ide and Richter (1984)

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Project: SCPP* (1983)

*Sierra Cooperative Pilot Project

Date(s): Jan. - Mar., 1983

Location(s): California (Windward Sierra Mountains)

Participating Aircraft: Univ. Wyoming (Beechcraft B-200T "King Air")

Number of Flights: 32

Estimated Value of Flights for data on:

Supercooled LWC	Fair (See note 1)
	Est. Max SLWC: 0.5 g/m ³
Snow	Good
Ice Particles	Good
Graupel	Good
Hail	---
Rain	---
Freezing Rain or Drizzle	---

Cloud Physics Probes in Use:

JW LWC Meter	(1-45 μ m)	Yes and SCIRO-King probe (See note 1)
PMS FSSP	(3-45 ")	Yes (See note 1)
PMS 1D-C (200X)	(20-300 ")	Yes
PMS 2D-C	(25-800 ")	Yes
PMS 1D-P (200Y)	(0.3-4.5 mm)	No
PMS 2D-P	(0.2-6.4 mm)	Yes
Ice Particle Counter		No
Particle Replicator		Yes
Icing Rate Meter		Yes

Cloud Types Sampled: St, Sc, orographic

Altitude Range for Data: Up to 15 k ft. (4.5 km) ASL

Data Custodian: Bureau of Reclamation, Denver, Colorado

Remarks: 1 - Many instrument problems this year with JW, FSSP and SCIRO-King probe.

Reference: "Project Skywater 1982-83 SCPP Data Inventory"

Project: SCPP* (1983)

*Sierra Cooperative Pilot Project

Date(s): Jan. - Mar., 1983

Location(s): California (Windward Sierra Mountains)

Participating Aircraft: Univ. North Dakota (Piper "Cheyenne II")

Number of Flights: 26

Estimated Value of Flights for data on:

Supercooled LWC	OK	(See Note 1)
		Est. Max SLWC: 1.8 g/m ³
Snow	---	
Ice Particles	Fair	(See Note 2)
Graupel	---	
Hail	---	
Rain	---	
Freezing Rain or Drizzle	---	

Cloud Physics Probes in Use:

JW LWC Meter	(1-45 μ m)	Yes
PMS FSSP or ASSP	(3-45 ")	No
PMS 1D-C (200X)	(20-300 ")	No
PMS 2D-C	(25-800 ")	No
PMS 1D-P (200Y)	(0.3-4.5 mm)	No
PMS 2D-P	(0.2-6.4 mm)	No
Ice Particle Counter		Yes (See note 2)
Particle Replicator		No
Icing Rate Meter		No

Cloud Types Sampled: St, Sc, orographic

Altitude Range for Data: Up to 11 k ft. (3.5 km) ASL

Data Custodian: Bureau of Reclamation, Denver, Colorado

Remarks: 1 - No FSSP available for LWC comparison.

2 - No information available on particle sizes or shapes

3 - This aircraft was used primarily for cloud seeding rather than for cloud microphysics measurements.

Reference:

Project: CRADP* (1983)

*Colorado River Augmentation Demonstration Program

Date(s): Jan. - Feb. and Nov., Dec., 1983

Location(s): Western Colorado

Participating Aircraft: Univ. North Dakota (Cessna "Citation II")

Number of Flights: 24

Estimated Value of Flights for data on:

Supercooled LWC	OK	Est. Max SLWC: 0.3 g/m ³
Snow	OK	
Ice Particles	OK	
Graupel	Poor	
Hail	---	
Rain	---	
Freezing Rain or Drizzle	---	

Cloud Physics Probes in Use:

JW LWC Meter	(1-45 μ m)	Yes (See note 1)
PMS FSSP	(3-45 ")	Yes (See note 1)
PMS 1D-C (200X)	(20-300 ")	No
PMS 2D-C	(25-800 ")	Yes
PMS 1D-P (200Y)	(0.3-4.5 mm)	Yes
PMS 2D-P	(0.2-6.4 mm)	No
Ice Particle Counter		No
Particle Replicator		No
Icing Rate Meter		Yes

Cloud Types Sampled: Cu, Sc, St
 Altitude Range for Data: 13 - 16 k ft. (4 - 5 km) ASL
 Data Custodian: Bureau of Reclamation, Denver, Colorado
 and Univ. North Dakota, Grand Forks, ND

Remarks: 1 - Occasional problems with ice accretion on probes.

Reference: "1983 CRADP Data Inventory"

Project: MASEX* (1983)

*Mesoscale Air-Sea Experiment

Date(s): Jan. 16-20, 1983

Location(s): Offshore New Jersey

Participating Aircraft: NOAA (Lockheed WP-3D)

Number of Flights: 4

Estimated Value of Flights for data on:

Supercooled LWC	?	(See note 1)
		Est. Max SLWC: 0.2 g/m ³
Snow	---	
Ice Particles	Good?	(See note 2)
Graupel	---	
Hail	---	
Rain	OK	
Freezing Rain or Drizzle	---	

Cloud Physics Probes in Use:

JW LWC Meter	(1-45 μ m)	Yes
PMS FSSP	(3-45 ")	Yes (See note 3)
PMS 1D-C (200X)	(20-300 ")	No
PMS 2D-C	(25-800 ")	Yes
PMS 1D-P (200Y)	(0.3-4.5 mm)	No
PMS 2D-P	(0.2-6.4 mm)	Yes
Ice Particle Counter		No
Particle Replicator		No
Icing Rate Meter		No

Cloud Types Sampled: Cellular Cu and streets in cold air over ocean.
 Altitude Range for Data: 1.5 - 12 k ft. (0.5 - 3.5 km) ASL
 Data Custodian: Contact Shu Chou or David Randall at Nasa/Goddard
 Space Flight Center, Greenbelt, MD

Remarks: 1 - LWC values appear to be relatively low, and most of flight time was below cloud level.
 2 - PMS-2D probes were in use only 1 sec out of each 10 sec interval, and there may have been some timing problems.
 3 - FSSP data were plagued by intermittent, uncorrectable errors. Also, no strobes or probe activity rates are available.

Project: NEWS* (1982-83)

*New England Winter Storms

Date(s): Dec. 1982 - Jan., 1983

Location(s): New England area

Participating Aircraft: NCAR (Beechcraft BE-80 "Queen Air")

Number of Flights: 8

Estimated Value of Flights for data on:

Supercooled LWC	OK	Est. Max SLWC: 0.5 g/m ³
Snow	OK	(See Note 1)
Ice Particles	OK	(See Note 1)
Graupel	---	
Hail	---	
Rain	Some	
Freezing Rain or Drizzle	---	

Cloud Physics Probes in Use:

JW LWC Meter	(1-45 μ m)	Yes
PMS FSSP	(3-45 ")	Yes
PMS 1D-C (200X)	(20-300 ")	No
PMS 2D-C	(25-800 ")	No
PMS 1D-P (200Y)	(0.3-4.5 mm)	Yes (See Note 1)
PMS 2D-P	(0.2-6.4 mm)	No
Ice Particle Counter		No
Particle Replicator		No
Icing Rate Meter		Yes

Cloud Types Sampled: Ns, St

Altitude Range for Data: 1 - 20 ft. (0.3 - 6 km) ASL

Data Custodian: NCAR Research Aviation Facility, Boulder, Colorado

Remarks: 1 - No information is available on particle shapes.

2 - Principal Investigator: Dr. R. E. Passarelli,
Massachusetts Institute of Technology, Cambridge,
Massachusetts.

Project: NOAA/NHRL Hurricane Flights (1982)

Date(s): Sept. 1982

Location(s): W. Atlantic, E. Pacific

Participating Aircraft: NOAA (Lockheed WP-3D)

Number of Flights: 1 (with cloud data above the 0°C level)
2 (with cloud data below the 0°C level)

Estimated Value of Flights for data on:

Supercooled LWC	Fair	Est. Max SLWC: ?
Snow	---	
Ice Particles	?	
Graupel	?	
Hail	---	
Rain	?	
Freezing Rain or Drizzle	---	

Cloud Physics Probes in Use:

JW LWC Meter	(1-45 μ m)	Yes
PMS FSSP	(3-45 ")	Yes (See note 1)
PMS 1D-C (200X)	(20-300 ")	No
PMS 2D-C	(25-800 ")	Yes
PMS 1D-P (200Y)	(0.3-4.5 mm)	No
PMS 2D-P	(0.2-6.4 mm)	Yes
Ice Particle Counter	(>100 μ m)	Yes
Particle Replicator (foil impactor)		Yes
Icing Rate Meter		No

Cloud Types Sampled: Hurricane tropical storms

Altitude Range for Data: 1.5-26 k ft (0.5-8 km)

Data Custodian: NOAA/AOML/HRD, Miami, Florida

Remarks: 1 - No strobes or probe activity rates are available.

Reference: Friedman et al (1984)

Project: GROSSVERSUCH IV (1982)

Date(s): August, 1982

Location(s): Switzerland

Participating Aircraft: SDSM&T (North American, T-28)

Number of Flights: 1

Estimated Value of Flights for data on:

Supercooled LWC	OK	Est. Max SLWC: 4.4 g m^{-3}
Snow	---	
Ice Particles	OK	
Graupel	OK	
Hail	OK	
Rain	---	
Freezing Rain or Drizzle	---	

Cloud Physics Probes in Use:

JW LWC Meter	(1-45 μm)	Yes
PMS FSSP	(3-45 ")	Yes
PMS 1D-C (200X)	(20-300 ")	No
PMS 2D-C	(25-800 ")	Yes
PMS 1D-P (200Y)	(0.3-4.5 mm)	No
PMS 2D-P	(0.2-6.4 mm)	No
Ice Particle Counter		No
Particle Replicator (foil impactor)		Yes
Icing Rate Meter		No
Hail Spectrometer		No
Cannon Camera		Yes

Cloud Types Sampled: Cb

Altitude Range for Data: to 20 k ft (6 km) ASL

Data Custodian: SDSM&T, Rapid City, SD

Remarks:

Reference:

Project: Alberta Hail Project (1982)

Date(s): June-Sept., 1982

Location(s): Alberta Province, Canada

Participating Aircraft: INTERA/ARC (Cessna 441 "Conquest")

Number of Flights: 19

Estimated Value of Flights for data on:

Supercooled LWC	Good	Est. Max SLWC: ?
Snow	?	
Ice Particles	Good	
Graupel	Good	
Hail	---	
Rain	Good	
Freezing Rain or Drizzle	---	

Cloud Physics Probes in Use:

JW LWC Meter	(1-45 μm)	Yes
PMS FSSP	(3-45 ")	Yes
PMS 1D-C (200X)	(20-300 ")	No
PMS 2D-C	(25-800 ")	Yes
PMS 1D-P (200Y)	(0.3-4.5 mm)	No
PMS 2D-P	(0.2-6.4 mm)	Yes
Ice Particle Counter		No
Particle Replicator		No
Icing Rate Meter		No

Cloud Types Sampled: Cu, Cb

Altitude Range for Data: Up to 20 k ft. (6 km) ASL

Data Custodian: Alberta Research Council, Edmonton, Alberta, Canada

Remarks:

Reference: "Alberta Hail Project Field Program 82"

Project: Upslope Cloud Studies (1982)

Date(s): March - May, 1982

Location(s): Northeastern Colorado

Participating Aircraft: Univ. North Dakota (Cessna "Citation II")

Number of Flights: 6

Estimated Value of Flights for data on:

Supercooled LWC	OK	Est. Max SLWC: 0.5 g/m^3
Snow	OK	
Ice Particles	OK	
Graupel	---	
Hail	---	
Rain	---	
Freezing Rain or Drizzle	---	

Cloud Physics Probes in Use:

JW LWC Meter	(1-45 μm)	Yes
PMS FSPP	(3-45 ")	Yes
PMS 1D-C (200X)	(20-300 ")	No
PMS 2D-C	(25-800 ")	Yes
PMS 1D-P (200Y)	(0.3-4.5 mm)	Yes
PMS 2D-P	(0.2-6.4 mm)	No
Ice Particle Counter	(100 m)	No
Particle Replicator		No
Icing Rate Meter		No

Cloud Types Sampled: St, As, Ns

Altitude Range for Data: 7-20 k ft (2-6 km) ASL

Data Custodian: Univ. North Dakota, Grand Forks, ND

Remarks: Project sponsored by NOAA/ERL, Boulder, Colorado

Reference:

Project: ALPEX* (1982)

*The GARP Alpine Experiment

Date(s): March-April, 1982

Location(s): Swiss Alps to Mediterranean Sea

Participating Aircraft: NOAA (Lockheed WP-3D)

Number of Flights: 17 (probably only half have useful cloud data)

Estimated Value of Flights for data on:

Supercooled LWC	Fair (See note 1)	Est. Max SLWC: low
Snow	?	
Ice Particles	OK (See note 2)	
Graupel	?	
Hail	---	
Rain	?	
Freezing Rain or Drizzle	?	

Cloud Physics Probes in Use:

JW LWC Meter	(1-45 μ m)	Yes
PMS FSSP	(3-45 ")	Yes (See notes 1,3)
PMS 1D-C (200X)	(20-300 ")	No
PMS 2D-C	(25-800 ")	No
PMS 1D-P (200Y)	(0.3-4.5 mm)	No
PMS 2D-P	(0.2-6.4 mm)	Yes (See note 3)
Ice Particle Counter		No
Particle Replicator		No
Icing Rate Meter		No

Cloud Types Sampled: Cyclonic, lee wave

Altitude Range for Data: Up to 20 k ft. (6 km) ASL

Data Custodian: Prof. Ron Smith, Dept. of Geology and Geophysics
Yale University, New Haven, Connecticut

Remarks: 1 - FSSP has undercounting errors due to airspeed and coincidence effects, and generally poor agreement with JW LWC. No strobes or probe activity rates are available.

2 - Clouds were not the primary mission of flights.
Also, most clouds were glaciated with low LWC and few precipitation size particles.

3 - PMS Data are not mentioned in Alpex data catalogs.

Reference: Kennedy and Frey (1983)

Project: ALPEX (1982)

Date(s): March-April, 1982

Location(s): Swiss Alps to Mediterranean Sea

Participating Aircraft: NCAR (Lockheed P-3 Electra)

Number of Flights: 19 (probably only half have useful cloud data)

Estimated Value of Flights for data on:

Supercooled LWC	Fair	Est. Max SLWC: low
Snow	?	
Ice Particles	OK	
Graupel	?	
Hail	---	
Rain	?	
Freezing Rain or Drizzle	?	

Cloud Physics Probes in Use:

JW LWC Meter	(1-45 μ m)	Yes
PMS FSSP	(3-45 ")	Yes
PMS 1D-C (200X)	(20-300 ")	Yes
PMS 2D-C	(25-800 ")	
PMS 1D-P (200Y)	(0.3-4.5 mm)	
PMS 2D-P	(0.2-6.4 mm)	
Ice Particle Counter		
Particle Replicator		
Icing Rate Meter		

Cloud Types Sampled: Cyclonic, lee wave

Altitude Range for Data: Up to 20 k ft. (6 km) ASL

Data Custodian: NCAR (?) or Prof. Ron Smith (Yale Univ.)

Remarks:

Reference: Kennedy and Frey (1983)

Project: ALPEX (1982)

Date(s): March-April, 1982

Location(s): Swiss Alps to Mediterranean Sea

Participating Aircraft: DFVLR (W. Germany) (Falcon)

Number of Flights: 19

Estimated Value of Flights for data on:

Supercooled LWC	---	Est. Max SLWC: low
Snow	---	
Ice Particles	---	
Graupel	---	
Hail	---	
Rain	---	
Freezing Rain or Drizzle	---	

Cloud Physics Probes in Use:

JW LWC Meter (1-45 μm)	No
PMS FSSP or ASSP (3-45 ")	No
PMS 1D-C (200X) (20-300 ")	No
PMS 2D-C (25-800 ")	No
PMS 1D-P (200Y) (0.3-4.5 mm)	No
PMS 2D-P (0.2-6.4 mm)	No
Ice Particle Counter	No
Particle Replicator	No
Icing Rate Meter	No

Cloud Types Sampled:

Altitude Range for Data:

Data Custodian: ?

Remarks: Radiation measurements only

Reference: Kennedy and Frey (1983)

Project: ARC* Snowpack Project (1982)

*Alberta Research Council

Date(s): March, 1982

Location(s): Alberta Province, Canada (mountains)

Participating Aircraft: INTERA/ARC (Cessna 441 "Conquest")

Number of Flights: 5

Estimated Value of Flights for data on:

Supercooled LWC	OK	Est. Max SLWC: 0.6 g/m ³
Snow	Good	
Ice Particles	Good	
Graupel	?	
Hail	---	
Rain	---	
Freezing Rain or Drizzle	---	

Cloud Physics Probes in Use:

JW LWC Meter (1-45 μm)	Yes
PMS FSSP (3-45 ")	Yes
PMS 1D-C (200X) (20-300 ")	No
PMS 2D-C (25-800 ")	Yes (See note 1)
PMS 1D-P (200Y) (0.3-4.5 mm)	No
PMS 2D-P (0.2-6.4 mm)	Yes
Ice Particle Counter	No
Particle Replicator	No
Icing Rate Meter	No

Cloud Types Sampled: Orographic and TCu, Cu, Ac

Altitude Range for Data: 11 to 14 k ft. (3-4 km) ASL

Data Custodian: Alberta Research Council, Edmonton, Alberta, Canada

Remarks: 1 - Particle images are all right but concentrations are faulty.

Reference: Barlow (1984)

Project: SCPP* (1981-82)

*Sierra Cooperative Pilot Project

Date(s): Jan. - March, 1982

Location(s): California (Windward Sierra Mountains)

Participating Aircraft: Univ. Wyoming (Beechcraft BE200T "King Air")

Number of Flights: 21 (with apparently useful cloud data)

Estimated Value of Flights for data on:

Supercooled LWC	Good	Est. Max SLWC: 1 g/m ³
Snow	?	
Ice Particles	Good	
Graupel	?	
Hail	---	
Rain	---	
Freezing Rain or Drizzle	---	

Cloud Physics Probes in Use:

JW LWC Meter (1-45 μm)	Yes (See note 1)
PMS FSSP (3-45 ")	Yes
PMS 1D-C (200X) (20-300 ")	Yes
PMS 2D-C (25-800 ")	Yes
PMS 1D-P (200Y) (0.3-4.5 mm)	No
PMS 2D-P (0.2-6.4 mm)	Yes
Ice Particle Counter	No
Particle Replicator	Yes
Icing Rate Meter	No

Cloud Types Sampled: Cu, Sc, and orographic Cb
 Altitude Range for Data: 2 - 26 k ft. (0.6 - 8 km) ASL
 Data Custodian: Bureau of Reclamation, Denver, Colorado

Remarks: 1 - First 4 cloud flights were with JW inoperative

Reference: Project Skywater Data inventory, 1981-82 SCPP season

Project: SCPP (1981-82)

Date(s): Jan. - Mar., 1982

Location(s): California (Windward Sierra Mountains)

Participating Aircraft: Univ. North Dakota (Piper, "Cheyenne II")

Number of Flights: 15 (with apparently useful cloud penetrations)

Estimated Value of Flights for data on:

Supercooled LWC	Fair (See note 1) Est. Max SLWC: ?
Snow	---
Ice Particles	Fair (See note 2)
Graupel	---
Hail	---
Rain	---
Freezing Rain or Drizzle	---

Cloud Physics Probes in Use:

JW LWC Meter (1-45 μm)	Yes
PMS FSSP or ASSP (3-45 ")	No
PMS 1D-C (200X) (20-300 ")	No
PMS 2D-C (25-800 ")	No
PMS 1D-P (200Y) (0.3-4.5 mm)	No
PMS 2D-P (0.2-6.4 mm)	No
Ice Particle Counter	Yes (See note 2)
Particle Replicator	No
Icing Rate Meter	No

Cloud Types Sampled: Cu, Cu
 Altitude Range for Data: ? up to 15 k ft. (4.5 km)?
 Data Custodian: Bureau Reclamation, Denver, Colorado

Remarks: 1 - No FSSP for comparison to JW-LWC.

2 - No information available on size or shape of particles.

Project: NOAA Ice Crystal Processes Program/Upslope Storms (1982)

Date(s): Jan. - Feb., 1982

Location(s): Eastern Colorado

Participating Aircraft: NOAA (Lockheed WP-3D)

Number of Flights: 5

Estimated Value of Flights for data on:

Supercooled LWC	Fair (See note 1)
	Est. Max SLWC: 0.3 g/m^3
Snow	Fair
Ice Particles	Good
Graupel	---
Hail	---
Rain	---
Freezing Rain or Drizzle	---

Cloud Physics Probes in Use:

JW LWC Meter	(1-45 μm)	Yes
PMS FSSP	(2-32 ")	Yes (See note 2)
PMS 1D-C (200X)	(20-300 ")	No
PMS 2D-C	(25-800 ")	Yes
PMS 1D-P (200Y)	(0.3-4.5 mm)	No
PMS 2D-P	(0.2-6.4 mm)	Yes
Ice Particle Counter		No
Particle Replicator		No
Icing Rate Meter		No

Cloud Types Sampled: Upslope St
 Altitude Range for Data: 1 - 6 k Ft. (.3 - 2 km) AGL
 Data Custodian: NOAA/ERL, Boulder, Colorado

Remarks: 1 - Very low LWC (avg 0.1 g/m^3) in these shallow upslope clouds from anticyclonic circulation, but horizontal extent is very wide.

2 - No strobes or probe activity rates are available.

Reference: Boatman and Reinking (1984).

Project: CYCLES* (1982)

*Cyclonic Extratropical Storms

Date(s): Jan., 1982

Location(s): Washington State coastline

Participating Aircraft: NOAA (Lockheed WP-3D)

Number of Flights: 5

Estimated Value of Flights for data on:

Supercooled LWC	?	Est. Max SLWC: ?
Snow	?	
Ice Particles	?	
Graupel	?	
Hail	---	
Rain	?	
Freezing Rain or Drizzle	?	

Cloud Physics Probes in Use:

JW LWC Meter	(1-45 μ m)	Yes
PMS FSSP	(3-45 ")	Yes (See note 1)
PMS 1D-C (200X)	(20-300 ")	No
PMS 2D-C	(25-800 ")	Yes
PMS 1D-P (200Y)	(0.3-4.5 mm)	No
PMS 2D-P	(0.2-6.4 mm)	Yes
Ice Particle Counter		No
Particle Replicator		No
Icing Rate Meter		No

Cloud Types Sampled: ?

Altitude Range for Data: ?

Data Custodian: University of Washington, Seattle, WA

Remarks: 1 - FSSP usually undercounts on P-3 due to fast airspeed.
No strobes or probe activity rates are available.

Project: CYCLES (1982)

Date(s): Jan. - Feb., 1982

Location(s): Washington State coastline

Participating Aircraft: Univ. Washington (Douglas B-23)

Number of Flights: 10

Estimated Value of Flights for data on:

Supercooled LWC	Ok	Est. Max SLWC: ?
Snow	Good	
Ice Particles	Good	
Graupel	?	
Hail	---	
Rain	?	
Freezing Rain or Drizzle	---	

Cloud Physics Probes in Use:

JW LWC Meter	(1-45 μ m)	Yes
PMS FSSP	(3-45 ")	Yes (See note 1)
PMS 1D-C (200X)	(20-300 ")	Yes
PMS 2D-C	(25-800 ")	Yes
PMS 1D-P (200Y)	(0.3-4.5 mm)	Yes
PMS 2D-P	(0.2-6.4 mm)	Yes
Ice Particle Counter		Yes
Particle Replicator		No
Icing Rate Meter		No

Cloud Types Sampled: Wave cyclones in maritime air masses.

Altitude Range for Data: ?

Data Custodian: Univ. Washington, Seattle, WA

Remarks: 1 - No strobes or probe activity rates recorded.

Project: COSE-III* (1981 - 82)

*Colorado Orographic Seeding Experiment

Date(s): Dec. 1981 - Jan., 1982

Location(s): Northwest Colorado

Participating Aircraft: Colorado Int'l Corp (Piper "Cheyenne II")

Number of Flights: 8

Estimated Value of Flights for data on:

Supercooled LWC	OK	Est. Max SLWC: ?
Snow	?	
Ice Particles	Good	
Graupel	?	
Hail	---	
Rain	---	
Freezing Rain or Drizzle	---	

Cloud Physics Probes in Use:

JW LWC Meter	(1-45 μ m)	Yes
PMS FSSP	(3-45 ")	Yes (See note 1)
PMS 1D-C (200X)	(20-300 ")	No
PMS 2D-C	(25-800 ")	Yes
PMS 1D-P (200Y)	(0.3-4.5 mm)	No
PMS 2D-P	(0.2-6.4 mm)	No
Ice Particle Counter		Yes
Particle Replicator		Yes
Icing Rate Meter		No

Cloud Types Sampled: Orographically assisted storm systems.

Altitude Range for Data: ?

Data Custodian: Colorado State Univ., Ft. Collins, Colorado

Remarks: 1 - FSSP was inoperative during the first few flights.

Reference: Rauber and Grant (1982).

Project: COSE-III (1981-82)

Date(s): Jan., 1982

Location(s): Northwest Colorado

Participating Aircraft: NOAA (Lockheed WP-3D)

Number of Flights: 3

Estimated Value of Flights for data on:

Supercooled LWC	?	Est. Max SLWC: ?
Snow	?	
Ice Particles	?	
Graupel	?	
Hail	---	
Rain	?	
Freezing Rain or Drizzle	?	

Cloud Physics Probes in Use:

JW LWC Meter	(1-45 μ m)	Yes
PMS FSSP	(3-45 ")	Yes (See note 1)
PMS 1D-C (200X)	(20-300 ")	No
PMS 2D-C	(25-800 ")	Yes
PMS 1D-P (200Y)	(0.3-4.5 mm)	No
PMS 2D-P	(0.2-6.4 mm)	Yes
Ice Particle Counter		No
Particle Replicator		No
Icing Rate Meter		No

Cloud Types Sampled: Orographically assisted storm systems.

Altitude Range for Data: 13-20 k ft. ASL; i.e., 1-8 k ft. (0.3 - 2.5 km) AGL

Data Custodian: Colorado State Univ., Ft. Collins, Colorado

Remarks: 1 - No strobes or probe activity rates are available.

Reference: Rauber and Grant (1982)

Project: NOAA/NHRL Hurricane Flights (1981)

Date(s): Sept., 1981

Location(s): 20°N and 30°N in the western No. Atlantic

Participating Aircraft: NOAA/NHRL (Lockheed WP-3D)

Number of Flights: 2 (with cloud data above the 0°C level)
13 (with cloud data below the 0°C level)

Estimated Value of Flights for data on:

Supercooled LWC	Fair (See notes 1,2)
	Est. Max SLWC: 2-3 g/m ³
Snow	?
Ice Particles	Good
Graupel	Good
Hail	---
Rain	Good
Freezing Rain or Drizzle	---

Cloud Physics Probes in Use:

JW LWC Meter	(1-45 μm)	Yes
PMS FSSP	(3-45 ")	Yes (See note 1)
PMS 1D-C (200X)	(20-300 ")	No
PMS 2D-C	(25-800 ")	Yes
PMS 1D-P (200Y)	(0.3-4.5 mm)	No
PMS 2D-P	(0.2-6.4 mm)	Yes
Ice Particle Counter		Yes
Particle Replicator		No
Icing Rate Meter		No

Cloud Types Sampled: Hurricane

Altitude Range for Data: 3-23 k ft. (1-7 km) ASL

Data Custodian: NOAA/NHRL, Coral Gables, Florida

Remarks: 1 - FSSP data have not been corrected for anything and the FSSP reportedly undercounts, giving computed LWCs only 1/10 to 1/2 the JW-LWC values. No strobes or probe activity rates are available.

2 - Hurricanes are reportedly well-glaciated above the 0°C level, so not much SLWC is found except in convective bands where SLWC can reach 2-3 g/m³ sometimes.

Reference: Friedman et al (1982)

Project: CCOPE* (1981)

*Cooperative Convective Precipitation Experiment

Date(s): May - July, 1981

Location(s): Montana

Participating Aircraft: Canadian AES/NAE (DeHavilland DH6,
"Twin Otter")

Number of Flights: 10 (flights with cloud data)

Estimated Value of Flights for data on:

Supercooled LWC	Good	Est. Max SLWC: 1 g/m ³
Snow	---	
Ice Particles	Fair	
Graupel	?	
Hail	?	
Rain	?	
Freezing Rain or Drizzle	---	

Cloud Physics Probes in Use:

JW LWC Meter	(1-45 μ m)	Yes
PMS FSSP	(3-45 ")	Yes
PMS 1D-C (200X)	(20-300 ")	Yes
PMS 2D-C	(25-800 ")	Yes
PMS 1D-P (200Y)	(0.3-4.5 mm)	Yes
PMS 2D-P	(0.2-6.4 mm)	Yes
Ice Particle Counter		No
Particle Replicator		No
Icing Rate Meter		No

Cloud Types Sampled: Cu, Cb
Altitude Range for Data: 15 k ft. (4.5 km) ASL
Data Custodian: Bureau of Reclamation, Denver, Colorado

Remarks:

Reference: "1981 CCOPE Data Inventory", and Knight (1981)

Project: CCOPE

Date(s): May-Aug., 1981

Location(s): Montana

Participating Aircraft: Univ. Wyoming (Beechcraft BE200T, "King Air")

Number of Flights: 28

Estimated Value of Flights for data on:

Supercooled LWC	Good	Est. Max SLWC: 4 g/m ³
Snow	---	
Ice Particles	Good	
Graupel	Good	
Hail	?	
Rain	---	
Freezing Rain or Drizzle	---	

Cloud Physics Probes in Use:

JW LWC Meter	(1-45 μ m)	Yes
PMS FSSP	(3-45 ")	Yes
PMS 1D-C (200X)	(20-300 ")	Yes
PMS 2D-C	(25-800 ")	Yes
PMS 1D-P (200Y)	(0.3-4.5 mm)	Yes
PMS 2D-P	(0.2-6.4 mm)	Yes
Ice Particle Counter		No
Particle Replicator		No
Icing Rate Meter		Yes

Cloud Types Sampled: Cu, Cb
Altitude Range for Data: 10-20 k ft. (3-6 km) ASL
Data Custodian: Bureau of Reclamation, Denver, Colorado

Remarks:

Reference: "1981 CCOPE Data Inventory", and Knight (1981)

Project: CCOPE

Date(s): May-Aug., 1981

Location(s): Montana

Participating Aircraft: NCAR (Beechcraft BE80, "Queen Air")

Number of Flights: 20

Estimated Value of Flights for data on:

Supercooled LWC	---	Est. Max SLWC: 0
Snow	---	
Ice Particles	---	
Graupel	---	
Hail	---	
Rain	?	
Freezing Rain or Drizzle	---	

Cloud Physics Probes in Use:

JW LWC Meter (1-45 μm)	Yes
PMS FSSP or ASSP (3-45 ")	No
PMS 1D-C (200X) (20-300 ")	No
PMS 2D-C (25-800 ")	No
PMS 1D-P (200Y) (0.3-4.5 mm)	Yes
PMS 2D-P (0.2-6.4 mm)	No
Ice Particle Counter	No
Particle Replicator	No
Icing Rate Meter	No

Cloud Types Sampled: ---

Altitude Range for Data: 10 k ft. (3 km) ASL

Data Custodian: Bureau of Reclamation, Denver, Colorado

Remarks: Sampled mainly in WFR conditions at cloud base level or below

References: "1981 CCOPE Data Inventory", and Knight (1981)

Project: CCOPE

Date(s): May - Aug., 1981

Location(s): Montana

Participating Aircraft: Univ. North Dakota (Cessna C-550, "Citation II")

Number of Flights: 13 (with PMS probe data, some LWC data)

Estimated Value of Flights for data on:

Supercooled LWC	Fair	Est. Max SLWC: 1 g/m ³
Snow	?	
Ice Particles	Good	
Graupel	?	
Hail	---	
Rain	?	
Freezing Rain or Drizzle	---	

Cloud Physics Probes in Use:

JW LWC Meter (1-45 μm)	Yes
PMS FSSP or ASSP (3-45 ")	No
PMS 1D-C (200X) (20-300 ")	No
PMS 2D-C (25-800 ")	Yes
PMS 1D-P (200Y) (0.3-4.5 mm)	Yes
PMS 2D-P (0.2-6.4 mm)	No
Ice Particle Counter	No
Particle Replicator	No
Icing Rate Meter	No

Cloud Types Sampled: Cu, Cb anvils mainly.

Altitude Range for Data: 10-27 k ft. (3-8 km) ASL

Data Custodian: Bureau of Reclamation, Denver, Colorado

Remarks: Aircraft used mostly for cloud photography. Some penetrations at high altitudes (anvils) ought to give good 2D data on ice particles. Not sure if much SLWC data at lower altitudes.

References: "1981 CCOPE Data Inventory", and Knight (1981)

Project: CCOPE

Date(s): May-Aug., 1981

Location(s): Montana

Participating Aircraft: NCAR (North American Rockwell N265, "Sabreliner")

Number of Flights: 13

Estimated Value of Flights for data on:

Supercooled LWC	Fair	Est. Max SLWC: 1 g/m ³
Snow	---	
Ice Particles	Good	
Graupel	---	
Hail	---	
Rain	---	
Freezing Rain or Drizzle	---	

Cloud Physics Probes in Use:

JW LWC Meter (1-45 μm)	Yes (See note 2)
PMS FSSP or ASSP (3-45 ")	No
PMS 1D-C (200X) (20-300 ")	No
PMS 2D-C (25-800 ")	Yes
PMS 1D-P (200Y) (0.3-4.5 mm)	No
PMS 2D-P (0.2-6.4 mm)	No
Ice Particle Counter	No
Particle Replicator	No
Icing Rate Meter	No

Cloud Types Sampled: Cb anvils mainly. Some legs are below freezing level.

Altitude Range for Data: 15-36 k ft. (4.5 - 11 km) ASL

Data Custodian: NCAR Convective Storms Division, Boulder, Colorado

Remarks: 1 - Aircraft used mainly for thermodynamic soundings near clouds, ice particles in anvils, and ozone near anvils.

2 - JW sensor was only available during the last half of the project.

References: "1981 CCOPE Data Inventory", and Knight (1981)

Project: CCOPE

Date(s): July-Aug., 1981

Location(s): Montana

Participating Aircraft: So. Dakota Schl Mines, (No. American, T-28)

Number of Flights: 11

Estimated Value of Flights for data on:

Supercooled LWC	Excellent	Est. Max SLWC: 6 g/m ³
Snow	?	
Ice Particles	OK	
Graupel	OK	
Hail	Excellent	
Rain	---	
Freezing Rain or Drizzle	---	

Cloud Physics Probes in Use:

JW LWC Meter (1-45 μm)	Yes
PMS FSSP (3-45 ")	Yes
PMS 1D-C (200X) (20-300 ")	No
PMS 2D-C (25-800 ")	Yes
PMS 1D-P (200Y) (0.3-4.5 mm)	No
PMS 2D-P (0.2-6.4 mm)	No
Ice Particle Counter	No
Particle Replicator	Yes
Icing Rate Meter	No
IAS Laser Hail Spectr. (5-50 mm)	Yes

Cloud Types Sampled: Cu, Cb

Altitude Range for Data: 15-25 k ft. (4.5-8 km) ASL

Data Custodian: NCAR Convective Storms Division, and SDSM&T.

Remarks: Aircraft mainly used for mature storm penetrations for data on LWC, hail and other hydrometeors.

References: "1981 CCOPE Data Inventory", and Knight (1981)

Project: CCOPE

Date(s): June-Aug., 1981

Location(s): Montana

Participating Aircraft: NCAR (Schweizer 2-32, Sailplane)

Number of Flights: 6 (See note 2)

Estimated Value of Flights for data on:

Supercooled LWC	OK	Est. Max SLWC: 1 g/m ³
Snow	---	
Ice Particles	---	
Graupel	---	
Hail	---	
Rain	---	
Freezing Rain or Drizzle	---	

Cloud Physics Probes in Use:

JW LWC Meter	(1-45 μ m)	Yes
PMS FSSP	(3-45 ")	Yes
PMS 1D-C (200X)	(20-300 ")	No
PMS 2D-C	(25-800 ")	No
PMS 1D-P (200Y)	(0.3-4.5 mm)	No
PMS 2D-P	(0.2-6.4 mm)	No
Ice Particle Counter		No
Particle Replicator		Yes
Icing Rate Meter		No

Cloud Types Sampled: Cu

Altitude Range for Data: 10-23 k ft. (3-7 km) ASL

Data Custodian: NCAR Convective Storms Division, Boulder, Colorado

Remarks: 1 - Sailplane data is of interest because of slow airspeed and therefore better spatial resolution as well as better operation of FSSP (negligible corrections for airspeed or particle activity rates).

2 - There are 6 flights with good JW data. Two or three other flights are in clouds with FSSP data, but clouds may not be supercooled.

References: "1981 CCOPE Data Inventory", and Knight (1981)

Project: CCOPE

Date(s): July-Aug., 1981

Location(s): Montana

Participating Aircraft: Univ. Wyoming (Beechcraft BE80, "Queen Air")

Number of Flights: 5 (with data above the freezing level)

Estimated Value of Flights for data on:

Supercooled LWC	OK	Est. Max SLWC: 1 g/m ³
Snow	---	
Ice Particles	---	
Graupel	---	
Hail	---	
Rain	---	
Freezing Rain or Drizzle	---	

Cloud Physics Probes in Use:

JW LWC Meter	(1-45 μ m)	Yes
PMS FSSP or ASSP	(3-45 ")	Yes
PMS 1D-C (200X)	(20-300 ")	No
PMS 2D-C	(25-800 ")	Yes
PMS 1D-P (200Y)	(0.3-4.5 mm)	No
PMS 2D-P	(0.2-6.4 mm)	No
Ice Particle Counter		No
Particle Replicator		Yes
Icing Rate Meter		No

Cloud Types Sampled: Cu, Cb

Altitude Range for Data: 10-20 k ft (3-6 km) ASL

Data Custodian: Bureau of Reclamation, Denver, Colorado

Remarks: Aircraft had many more than 5 flights but they were plagued by electrical power problems. Also many early flights were low altitude (boundary layer) flights.

References: "1981 CCOPE Data Inventory", and Knight (1981)

Project: CCOPE

Date(s): June-Aug, 1981

Location(s): Montana

Participating Aircraft: Desert Research Institute (Aero Commander AC-69)

Number of Flights: 12

Estimated Value of Flights for data on:

Supercooled LWC	Good	Est. Max SLWC: 2 g/m ³
Snow	---	
Ice Particles	OK	
Graupel	?	
Hail	---	
Rain	---	
Freezing Rain or Drizzle	---	

Cloud Physics Probes in Use:

JW LWC Meter (1-45 μm)	Yes
PMS FSSP or ASSP (3-45 ")	Yes
PMS 1D-C (200X) (20-300 ")	No
PMS 2D-C (25-800 ")	Yes
PMS 1D-P (200Y) (0.3-4.5 mm)	No
PMS 2D-P (0.2-6.4 mm)	No
Ice Particle Counter	No
Particle Replicator	Yes
Icing Rate Meter	No

Cloud Types Sampled: Cu, Cb

Altitude Range for Data: 10-25 k ft. (3-8 km) ASL

Data Custodian: NCAR Convective Storms Division, Boulder, Colorado

References: "1981 CCOPE Data Inventory", and Knight (1981)

Project: Cloud Chemistry (1981)

Date(s): May and Sept., 1981

Location(s): Washington State

Participating Aircraft: Univ. Washington (Douglas, B-23)

Number of Flights: 3

Estimated Value of Flights for data on:

Supercooled LWC	Good	Est. Max SLWC: 1 g/m ³
Snow	---	
Ice Particles	---	
Graupel	Fair	
Hail	Fair	
Rain	Fair	
Freezing Rain or Drizzle	---	

Cloud Physics Probes in Use:

JW LWC Meter (1-45 μm)	Yes
PMS ASSP (3-45 ")	Yes
PMS 1D-C (200X) (20-300 ")	Yes
PMS 2D-C (25-800 ")	Yes
PMS 1D-P (200Y) (0.3-4.5 mm)	Yes
PMS 2D-P (0.2-6.4 mm)	Yes
Ice Particle Counter	Yes
Particle Replicator	No
Icing Rate Meter	No

Cloud Types Sampled: Cu

Altitude Range for Data: 4-12 k ft. (1-4 km) ASL

Data Custodian: Univ. Washington, Seattle, Washington

Remarks: ASSP no good during flight 1016, and some problems with PMS 2D-P on two flights.

Project: Cumulus Studies (1981)

Date(s): Mar.-Apr. and July-Aug., 1981

Location(s): Washington State

Participating Aircraft: Univ. Washington (B-23)

Number of Flights: 6

Estimated Value of Flights for data on:

Supercooled LWC	Good	Est. Max SLWC: 2 g/m ³
Snow	---	
Ice Particles	Good (See note 1)	
Graupel	Good	
Hail	---	
Rain	---	
Freezing Rain or Drizzle	---	

Cloud Physics Probes in Use:

JW LWC Meter	(1-45 μ m)	Yes
PMS ASSP	(3-45 ")	Yes
PMS 1D-C (200X)	(20-300 ")	Yes
PMS 2D-C	(25-800 ")	Yes
PMS 1D-P (200Y)	(0.3-4.5 mm)	Yes
PMS 2D-P	(0.2-6.4 mm)	Yes
Ice Particle Counter		Yes
Particle Replicator		No
Icing Rate Meter		No

Cloud Types Sampled: Cu, Sc, TCu, Cb, St
 Altitude Range for Data: 2-18 k ft. (0.6-5.5 km) ASL
 Data Custodian: Univ. Washington, Seattle, Washington

Remarks: 1 - Occasional problems with ice particle counter and various PMS probes.

Project: USAF/AFGL LSCS* (1981)

*Large Scale Cloud Systems

Date(s): Mar.-Apr., 1981

Location(s): WI, ME, NY, NH

Participating Aircraft: USAF/AFGL (Lockheed MC-130E)

Number of Flights: 8

Estimated Value of Flights for data on:

Supercooled LWC	OK	Est. Max SLWC: ?
Snow	Good	
Ice Particles	Good	
Graupel	?	
Hail	---	
Rain	---	
Freezing Rain or Drizzle	?	

Cloud Physics Probes in Use:

JW LWC Meter	(1-45 μ m)	Yes
PMS FSSP or ASSP	(3-45 ")	Yes
PMS 1D-C (200X)	(20-300 ")	Yes
PMS 2D-C	(25-800 ")	Yes
PMS 1D-P (200Y)	(0.3-4.5 mm)	Yes
PMS 2D-P	(0.2-6.4 mm)	Yes
Ice Particle Counter		No
Particle Replicator		Yes
Icing Rate Meter		Yes

Cloud Types Sampled:
 Altitude Range for Data: Up to 29 k ft.
 Data Custodian: AFGL/LYC, Hanscom AFB, Massachusetts. (But will require funding to prepare data for use outside AFGL).

Remarks: Regular multilevel sampling at altitudes of 300 mb (29,000 ft.), 400 mb (23,000 ft.), 500 mb (18,500 ft.), 700 mb (10,000 ft.), and 850 mb (5,000 ft.), and occasional spiral sounding.

Reference: Barnes et al (1982)

Project: USAF/AFGL Aircraft Icing Project (1981)

Date(s): Mar., Apr., 1981

Location(s): IN, NY, MA, ME

Participating Aircraft: USAF/AFGL (Lockheed MC-130E)

Number of Flights: 8

Estimated Value of Flights for data on:

Supercooled LWC	OK	Est. Max SLWC: 1 g/m ³
Snow	Good	
Ice Particles	Good	
Graupel	?	
Hail	---	
Rain	?	
Freezing Rain or Drizzle	?	

Cloud Physics Probes in Use:

JW LWC Meter (1-45 μm)	Yes
PMS FSSP or ASSP (3-45 ")	Yes
PMS 1D-C (200X) (20-300 ")	Yes
PMS 2D-C (25-800 ")	Yes
PMS 1D-P (200Y) (0.3-4.5 mm)	Yes
PMS 2D-P (0.2-6.4 mm)	Yes
Ice Particle Counter	No
Particle Replicator	Yes
Icing Rate Meter	Yes

Cloud Types Sampled: Mostly wintertime cloud systems

Altitude Range for Data: 5-22 k ft. (1.5-6.5 km) ASL

Data Custodian: AFGL/LYC, Hanscom AFB, Massachusetts (But will require funding to prepare data for use outside AFGL.)

Remarks:

Reference: Cohen (1983)

Project: Icing Research Flights (1981)

Date(s): Mar.-April, 1981

Location(s): Great Lakes area, eastern seaboard and offshore

Participating Aircraft: NRL (Lockheed P-3)

Number of Flights: 4

Estimated Value of Flights for data on:

Supercooled LWC	Good	Est. Max SLWC: 1 g/m ³
Snow	---	
Ice Particles	---	
Graupel	---	
Hail	---	
Rain	---	
Freezing Rain or Drizzle	---	

Cloud Physics Probes in Use:

JW LWC Meter (1-45 μm)	Yes (See note 1)
PMS ASSP (3-45 ")	Yes (See note 1)
PMS 1D-C (200X) (20-300 ")	Yes (See note 1)
PMS 2D-C (25-800 ")	No
PMS 1D-P (200Y) (0.3-4.5 mm)	No
PMS 2D-P (0.2-6.4 mm)	No
Ice Particle Counter	No
Particle Replicator	No
Icing Rate Meter	Yes

Cloud Types Sampled: St, Sc, Ns

Altitude Range for Data: 3-10 k ft.

Data Custodian: Naval Research Laboratory, Washington, DC. (But funding will be needed to prepare data for use outside NRL.
Principal Investigator: Richard K. Jeck)

Remarks: 1 - Some instrument problems.

Reference: Jeck (1983)

Project: PEP* (1981)

*Precipitation Enhancement Project

Date(s): Feb. - May, 1981

Location(s): Spain

Participating Aircraft: Univ. Wyoming (Beechcraft BE-80 "Queen Air")

Number of Flights: 52

Estimated Value of Flights for Data on:

Supercooled LWC	Good	Est. Max SLWC:
Snow	?	
Ice Particles	Good	
Graupel	?	
Hail	---	
Rain	?	
Freezing Rain or Drizzle	---	

Cloud Physics Probes in Use:

JW LWC Meter	(1-45 μ m)	Yes
PMS FSSP or ASSP	(3-45 ")	Yes
PMS 1D-C (200X)	(20-300 ")	No
PMS 2D-C	(25-800 ")	Yes
PMS 1D-P (200Y)	(0.3-4.5 mm)	No
PMS 2D-P	(0.2-6.4 mm)	No
Ice Particle Counter	(100 m)	No
Particle Replicator		Yes
Icing Rate Meter		No

Cloud Types Sampled: Ns, Cu, St, Ac, Cb, Sc, As, Cu cong.

Altitude Range for Data:

Data Custodian: Univ. Wyoming, Laramie, WY

Remarks:

Reference: WMO PEP Report No. 26 (1981)

Project: PEP (1981)

Date(s): March - May, 1981

Location(s): Spain

Participating Aircraft: L.A.M.P./Univ. Clermont II (Piper "Aztec")

Number of Flights: 28

Estimated Value of Flights for Data on:

Supercooled LWC	Good	Est. Max SLWC: 2 g/m ³
Snow	?	
Ice Particles	Good	
Graupel	?	
Hail	---	
Rain	?	
Freezing Rain or Drizzle	---	

Cloud Physics Probes in Use:

JW LWC Meter	(1-45 μ m)	Yes
PMS ASSP	(3-45 ")	Yes
PMS 1D-C (200X)	(20-300 ")	No
PMS 2D-C	(25-800 ")	Yes
PMS 1D-P (200Y)	(0.3-4.5 mm)	No
PMS 2D-P	(0.2-6.4 mm)	No
Ice Particle Counter	(100 m)	No
Particle Replicator		No
Icing Rate Meter		No

Cloud Types Sampled: Cu, Cu cong., As, Sc, Ci, Ac

Altitude Range for Data:

Data Custodian: LAMP, Univ. Clermont II, 63170 Aubiere, France

Remarks:

Reference: WMO PEP Report No. 26 (1981)

Project: Cloud Seeding Experiments (1981)

Date(s): Feb.-Mar., 1981

Location(s): Southwestern Utah

Participating Aircraft: Univ. Washington (Douglas B-23)

Number of Flights: 6

Estimated Value of Flights for data on:

Supercooled LWC	Good	Est. Max SLWC: 1 g/m ³
Snow	Good	
Ice Particles	Excellent (except see note 1)	
Graupel	Good	
Hail	---	
Rain	---	
Freezing Rain or Drizzle	---	

Cloud Physics Probes in Use:

JW LWC Meter	(1-45 μ m)	Yes
PMS ASSP	(3-45 ")	Yes
PMS 1D-C (200X)	(20-300 ")	Yes
PMS 2D-C	(25-800 ")	Yes
PMS 1D-P (200Y)	(0.3-4.5 mm)	Yes
PMS 2D-P	(0.2-6.4 mm)	Yes
Ice Particle Counter		Yes
Particle Replicator		No
Icing Rate Meter		No

Cloud Types Sampled: St, Sc, Oro Sc-Cu, Ac (lenticular), As, Cu, small Cb.
Altitude Range for Data: 5-16 k ft. (1.5-5 km) ASL over mountains
Data Custodian: Univ. Washington, Seattle, Washington

Remarks: 1 - Frequent problems with PMS 1 D-C, ice particle counter, and air temperature sensor; some problems with 2 D-P probe and airspeed sensor.

2 - Some special cases: a) Ice accretion of 3/4" to 1" during flights 970 and 971; b) possible good cases of mixed phase clouds during flight 975; c) some clouds liquid on top with ice falls below during flight 975 also.

Project: Univ. Chicago Lake-Effect Snow Project (1980-81)

Date(s): Dec. 1980 - Jan., 1981

Location(s): Lake Michigan vicinity

Participating Aircraft: Univ. Wyoming (Beechcraft BE-200T "King Air")

Number of Flights: 16

Estimated Value of Flights for data on:

Supercooled LWC	Good	Est. Max SLWC: 0.6 g/m ³
Snow	Good	
Ice Particles	Good	
Graupel	OK	
Hail	---	
Rain	---	
Freezing Rain or Drizzle	Some	

Cloud Physics Probes in Use:

JW LWC Meter	(1-45 μ m)	Yes (and CSIRO-King probe)
PMS FSSP	(3-45 ")	Yes
PMS 1D-C (200X)	(20-300 ")	yes
PMS 2D-C	(25-800 ")	Yes
PMS 1D-P (200Y)	(0.3-4.5 mm)	No
PMS 2D-P	(0.2-6.4 mm)	Yes
Ice Particle Counter		No
Particle Replicator		Yes
Icing Rate Meter		No

Cloud Types Sampled: St, Sc

Altitude Range for Data: 1-15 k ft. (0.3-4.5 km) ASL

Data Custodian: Univ. Wyoming, Laramie, Wyoming

(Principal Investigator: Prof. R. R. Braham, Univ. Chicago)

Remarks:

Project: Univ. Chicago Lake-Effect Snow Project (1980-81)

Date(s): Dec. 1980 - Jan., 1981

Location(s): Lake Michigan vicinity

Participating Aircraft: NCAR (Beechcraft BE-80 "Queen Air")

Number of Flights: 13

Estimated Value of Flights for data on:

Supercooled LWC	Good	Est. Max SLWC: 0.6 g/m ³
Snow	OK (See note 1)	
Ice Particles	OK (See note 1)	
Graupel	---	
Hail	---	
Rain	---	
Freezing Rain or Drizzle	---	

Cloud Physics Probes in Use:

JW LWC Meter	(1-45 μ m)	Yes
PMS FSSP	(3-45 ")	Yes
PMS 1D-C (200X)	(20-300 ")	No
PMS 2D-C	(25-800 ")	No
PMS 1D-P (200Y)	(0.3-4.5 mm)	Yes (See note 1)
PMS 2D-P	(0.2-6.4 mm)	No
Ice Particle Counter		No
Particle Replicator		No
Icing Rate Meter		Yes

Cloud Types Sampled: St, Sc

Altitude Range for Data: Less than 15 k ft. (4.5 km) ASL

Data Custodian: NCAR, Research Aviation Facility, Boulder, Colorado

Remarks: 1 - No information available on particle shapes

Project: USAF/AFGL LSCS* (1980)

*Large Scale Cloud Systems

Date(s): Jan. - March, and Oct., Dec., 1980

Location(s): WA, NE, PA, MA, OH

Participating Aircraft: USAF/AFGL (Lockheed MC-130E)

Number of Flights: 9

Estimated Value of Flights for data on:

Supercooled LWC	OK (See note 1)
	Est. Max SLWC: 0.5 g/m ³
Snow	Excellent
Ice Particles	Good
Graupel	?
Hail	---
Rain	?
Freezing Rain or Drizzle	?

Cloud Physics Probes in Use:

JW LWC Meter	(1-45 μ m)	Yes
PMS FSSP or ASSP	(3-45 ")	Yes
PMS 1D-C (200X)	(20-300 ")	Yes
PMS 2D-C	(25-800 ")	Yes
PMS 1D-P (200Y)	(0.3-4.5 mm)	Yes
PMS 2D-P	(0.2-6.4 mm)	Yes
Ice Particle Counter		No
Particle Replicator		Yes
Icing Rate Meter		Yes

Cloud Types Sampled: Mostly wintertime wave cyclones and snowstorms.

Altitude Range for Data: Up to 29 k ft. (9 km) ASL

Data Custodian: AFGL/LYC, Hanscom AFB, Massachusetts. (But funding will be required to prepare data for use outside AFGL.)

Remarks: 1 - Clouds were mostly glaciated and therefore LWC was minimal.)

Reference: Barnes et al (1982)

Project: PACE* (1980)

*Precipitation Augmentation for Crops Experiment

Date(s): Aug., 1980

Location(s): Illinois

Participating Aircraft: Univ. Wyoming (Beechcraft BE-200T "King Air")

Number of Flights: 4

Estimated Value of Flights for data on:

Supercooled LWC	Good	Est. Max SLWC: 2 g/m ³
Snow	---	
Ice Particles	?	
Graupel	?	
Hail	---	
Rain	---	
Freezing Rain or Drizzle	---	

Cloud Physics Probes in Use:

JW LWC Meter	(1-45 μ m)	Yes
PMS FSSP	(3-45 ")	Yes
PMS 1D-C (200X)	(20-300 ")	Yes
PMS 2D-C	(25-800 ")	Yes
PMS 1D-P (200Y)	(0.3-4.5 mm)	No
PMS 2D-P	(0.2-6.4 mm)	Yes
Ice Particle Counter		No
Particle Replicator		Yes?
Icing Rate Meter		No

Cloud Types Sampled: Cu, As, Ac

Altitude Range for Data: 20 k ft.? (6 km?) ASL

Data Custodian: Univ. Wyoming, Laramie, Wyoming

Remarks:

Reference: Achtemeier, et al (1983)

Project: NOAA/NHRL Hurricane Flights (1980)

Date(s): Aug., 1980

Location(s): Caribbean, Gulf of Mexico

Participating Aircraft: NOAA/NHRL (Lockheed WP-3D)

Number of Flights: 2 (with cloud data above the 0°C level)
6 (with cloud data below the 0°C level)

Estimated Value of Flights for data on:

Supercooled LWC	Fair (See notes 1 and 2)
	Est. Max SLWC: 2-3 g/m ³
Snow	?
Ice Particles	Good
Graupel	Good
Hail	---
Rain	Good
Freezing Rain or Drizzle	---

Cloud Physics Probes in Use:

JW LWC Meter	(1-45 μm)	Yes
PMS FSSP	(3-45 ")	Yes (See note 1)
PMS 1D-C (200X)	(20-300 ")	No
PMS 2D-C	(25-800 ")	Yes
PMS 1D-P (200Y)	(0.3-4.5 mm)	No
PMS 2D-P	(0.2-6.4 mm)	Yes
Ice Particle Counter		No
Particle Replicator (foil impactor)		Yes
Icing Rate Meter		No

Cloud Types Sampled: Hurricane

Altitude Range for Data: 5-20 k ft. (1.5-6 km) ASL

Data Custodian: NOAA/NHRL, Coral Gables, Florida

Remarks: 1 - FSSP data have not been corrected for anything; probe reportedly gives low counts and 1/10 to 1/2 the JW-LWC. No strobes or probe activity rates are available.

2 - Hurricanes are reportedly well-glaciated above the 0°C level, so not much SLWC is found except in convective bands where SLWC can reach 2-3 g/m³ sometimes.

Reference: Friedman et al (1982)

Project: FACE*-II (1980)

*Florida Area Cumulus Experiment

Date(s): June - Aug., 1980

Location(s): Florida

Participating Aircraft: Aero Systems, Inc. (North American Rockwell, "Aero Commander")

Number of Flights: 26

Estimated Value of Flights for data on:

Supercooled LWC	OK (See note 1)	Est. Max SLWC: ?
Snow	?	
Ice Particles	Good (See note 3)	
Graupel	Good (See note 3)	
Hail	?	
Rain	---	
Freezing Rain or Drizzle	---	

Cloud Physics Probes in Use:

JW LWC Meter	(1-45 μm)	Yes
PMS FSSP or ASSP	(3-45 ")	No
PMS 1D-C (200X)	(20-300 ")	No
PMS 2D-C	(25-800 ")	Yes (See note 2)
PMS 1D-P (200Y)	(0.3-4.5 mm)	Yes (See note 2)
PMS 2D-P	(0.2-6.4 mm)	No
Ice Particle Counter		Yes
Particle Replicator		Yes
Icing Rate Meter		No

Cloud Types Sampled: Cu

Altitude Range for Data: -10°C level (15-20 k ft.) (4.5-6 km) ASL

Data Custodian: NOAA/ERL, Boulder, Colorado

Remarks: 1 - No FSSP was available for comparison with JW LWCs.

2 - PMS probes offline or inoperative during first half of field deployment, and data tapes may not be available for some of the PMS measurements.

3 - See especially the DRI replicator data (ref. 1)

References: 1 - Jordan, Hallett, and Reinking (1981)

2 - "1980 FACE Operational Summary and Data Inventory"

Project: Arctic Stratus Experiment (1980)

Date(s): June, 1980

Location(s): Beaufort Sea

Participating Aircraft: NCAR (Lockheed, "Electra")

Number of Flights: 6

Estimated Value of Flights for data on:

Supercooled LWC	Ok (See note 1)
	Est. Max SLWC: 0.6 g/m ³
Snow	---
Ice Particles	---
Graupel	---
Hail	---
Rain	---
Freezing Rain or Drizzle	---

Cloud Physics Probes in Use:

JW LWC Meter	(1-45 μ m)	Defective (See note 2)
PMS FSSP	(3-45 ")	Yes
PMS 1D-C (200X)	(20-300 ")	Yes
PMS 2D-C	(25-800 ")	No
PMS 1D-P (200Y)	(0.3-4.5 mm)	No
PMS 2D-P	(0.2-6.4 mm)	No
Ice Particle Counter		No
Particle Replicator		No
Icing Rate Meter		No

Cloud Types Sampled: Stratus

Altitude Range for Data: 0.1 to 15 k ft. (0-4.5 km) ASL

Data Custodian: NCAR, Research Aviation Facility, Boulder, Colorado

Remarks: 1 - Temperature in some clouds was up to +40°C

2 - JW probe inoperative, but FSSP claimed to be reliable for LWC.

References: Herman and Curry (1984)
Jayaweera and Tsay (1982)

Project: HIPLEX* (1980)

*High Plains Cooperative Program

Date(s): May-July, 1980

Location(s): Montana

Participating Aircraft: Univ. Wyoming (Beechcraft BE-100T, "King Air")

Number of Flights: 30

Estimated Value of Flights for data on:

Supercooled LWC	Good	Est. Max SLWC: ?
Snow	?	
Ice Particles	Good	
Graupel	?	
Hail	---	
Rain	OK	
Freezing Rain or Drizzle	---	

Cloud Physics Probes in Use:

JW LWC Meter	(1-45 μ m)	Yes
PMS FSSP or ASSP	(3-45 ")	Yes
PMS 1D-C (200X)	(20-300 ")	Yes
PMS 2D-C	(25-800 ")	Yes
PMS 1D-P (200Y)	(0.3-4.5 mm)	No
PMS 2D-P	(0.2-6.4 mm)	Yes
Ice Particle Counter		No
Particle Replicator		Yes
Icing Rate Meter		

Cloud Types Sampled: Cu, Cb, St
 Altitude Range for Data: 10-25 k ft. (3-7.5 km) ASL
 Data Custodian: Bureau of Reclamation, Denver, Colorado

Remarks: Aircraft normally operated at mid-cloud level

Reference: "Project Skywater Data Inventory: 1980 HIPLEX Season"

Project: HIPLEX (1980)

Date(s): May - July, 1980

Location(s): Montana, Texas

Participating Aircraft: Colorado International Corporation (Learjet 24A)

Number of Flights: 27

Estimated Value of Flights for data on:

Supercooled LWC	OK (See note 2)
	Est. Max SLWC: 2 g/m ³
Snow	?
Ice Particles	Good
Graupel	?
Hail	---
Rain	---
Freezing Rain or Drizzle	---

Cloud Physics Probes in Use:

JW LWC Meter	(1-45 μ m)	Yes
PMS FSSP or ASSP	(3-45 ")	No (See note 2)
PMS 1D-C (200X)	(20-300 ")	No
PMS 2D-C	(25-800 ")	Yes
PMS 1D-P (200Y)	(0.3-4.5 mm)	No
PMS 2D-P	(0.2-6.4 mm)	No
Ice Particle Counter		Yes (See note 3)
Particle Replicator		No
Icing Rate Meter		No

Cloud Types Sampled: Cu, Cb
 Altitude Range for Data: 15-25 k ft. (4.5 - 7.5 km) ASL
 Data Custodian: Bureau of Reclamation, Denver, Colorado

Remarks: 1 - Aircraft normally operated just below (100-1000 ft) cloud top.

2 - No FSSP was available for comparison with JW LWCs.

3 - Ice particle counter data are questionable.

Project: HIPLEX (1980)

Date(s): May - June, 1980

Location(s): Montana

Participating Aircraft: Canadian AES/NAE (DeHavilland DH6 "Twin Otter")

Number of Flights: 17

Estimated Value of Flights for data on:

Supercooled LWC	Poor (See note 1) Est. Max SLWC: ?
Snow	---
Ice Particles	---
Graupel	---
Hail	---
Rain	?
Freezing Rain or Drizzle	---

Cloud Physics Probes in Use:

JW LWC Meter (1-45 μm)	Yes
PMS FSSP or ASSP (3-45 ")	Yes
PMS 1D-C (200X) (20-300 ")	Yes
PMS 2D-C (25-800 ")	Yes
PMS 1D-P (200Y) (0.3-4.5 mm)	Yes
PMS 2D-P (0.2-6.4 mm)	Yes
Ice Particle Counter	Yes
Particle Replicator	Yes
Icing Rate Meter	No

Cloud Types Sampled: Cu, TCu, St
 Altitude Range for Data: 5-15 k ft. (1.5-4.5 km) ASL
 Data Custodian: Bureau of Reclamation, Denver, Colorado

Remarks: 1 - Aircraft operated primarily near cloud base.
 Therefore, LWC values are small and temperatures are generally warmer than freezing.

Project: HIPLEX (1980)

Date(s): June - July, 1980

Location(s): Texas

Participating Aircraft: Colorado River Municipal Water District
 (Piper PA31-P, "Navajo")

Number of Flights: 11

Estimated Value of Flights for data on:

Supercooled LWC	OK (See note 1) Est. Max SLWC: 1 g/m ³
Snow	---
Ice Particles	Good
Graupel	---
Hail	---
Rain	---
Freezing Rain or Drizzle	---

Cloud Physics Probes in Use:

JW LWC Meter (1-45 μm)	Yes
PMS FSSP or ASSP (3-45 ")	Yes
PMS 1D-C (200X) (20-300 ")	No
PMS 2D-C (25-800 ")	Yes
PMS 1D-P (200Y) (0.3-4.5 mm)	No
PMS 2D-P (0.2-6.4 mm)	No
Ice Particle Counter	Yes
Particle Replicator	No
Icing Rate Meter	No

Cloud Types Sampled: Cu, Ac
 Altitude Range for Data: -100 level
 Data Custodian: Bureau of Reclamation, Denver, Colorado

Remarks: 1 - Aircraft flew mostly at the -100C seeding level (if there was one) for cloud measurements. Most clouds were weak and poorly developed.

Reference: Alexander and Reggis (1981)

Project: HIPLEX (1980)

Date(s): May - June, 1980

Location(s): Texas

Participating Aircraft: NCAR (Beechcraft BE-80, "Queen Air")

Number of Flights: 6

Estimated Value of Flights for data on:

Supercooled LWC	OK (See note 1)
	Est. Max SLWC: 1 g/m ³
Snow	?
Ice Particles	?
Graupel	?
Hail	---
Rain	---
Freezing Rain or Drizzle	---

Cloud Physics Probes in Use:

JW LWC Meter (1-45 μm)	Yes
PMS FSSP or ASSP (3-45 ")	Yes
PMS 1D-C (200X) (20-300 ")	No
PMS 2D-C (25-800 ")	No
PMS 1D-P (200Y) (0.3-4.5 mm)	Yes
PMS 2D-P (0.2-6.4 mm)	No
Ice Particle Counter	No
Particle Replicator	No
Icing Rate Meter	Yes

Cloud Types Sampled: Cu

Altitude Range for Data: -50°C level

Data Custodian: Bureau of Reclamation, Denver, Colorado

Remarks: 1 - Only about 6 flights took place in probable supercooled clouds.
A number of other flights occurred in small, warm cumulus.

Project: Cumulus Studies (1980)

Date(s): Mar. - May, 1980

Location(s): Western and Central Washington State

Participating Aircraft: Univ. Washington (Douglas B-23)

Number of Flights: 7

Estimated Value of Flights for data on:

Supercooled LWC	Good	Est. Max SLWC: 0.5 g/m ³
Snow	Fair	
Ice Particles	Good	
Graupel	Good	
Hail	---	
Rain	---	
Freezing Rain or Drizzle	---	

Cloud Physics Probes in Use:

JW LWC Meter (1-45 μm)	Yes
PMS ASSP (3-45 ")	Yes
PMS 1D-C (200X) (20-300 ")	Yes (See note 1)
PMS 2D-C (25-800 ")	Yes
PMS 1D-P (200Y) (0.3-4.5 mm)	Yes
PMS 2D-P (0.2-6.4 mm)	?
Ice Particle Counter	Yes
Particle Replicator	No
Icing Rate Meter	No

Cloud Types Sampled: Sc, Cb, TCu, Cu

Altitude Range for Data: 2-20 k ft. (0.6 - 6 km) ASL

Data Custodian: Univ. Washington, Seattle, Washington

Remarks: 1 - PMS 1D-C probe malfunctioned for all flights

Project: PEP* (1980)

*Precipitation Enhancement Project

Date(s): Feb. - May, 1980

Location(s): Spain

Participating Aircraft: Univ. Wyoming (Beechcraft BE-80 "Queen Air")

Number of Flights: 46

Estimated Value of Flights for Data on:

Supercooled LWC	Good	Est. Max SLWC:
Snow	?	
Ice Particles	Good	
Graupel	?	
Hail	---	
Rain	?	
Freezing Rain or Drizzle	---	

Cloud Physics Probes in Use:

JW LWC Meter	(1-45 μ m)	Yes
PMS ASSP	(3-45 ")	Yes
PMS 1D-C (200X)	(20-300 ")	No
PMS 2D-C	(25-800 ")	Yes
PMS 1D-P (200Y)	(0.3-4.5 mm)	No
PMS 2D-P	(0.2-6.4 mm)	No
Ice Particle Counter	(100 m)	No
Particle Replicator		Yes
Icing Rate Meter		No

Cloud Types Sampled: Cu, Cu cong., As, Sc, Ci, Ac

Altitude Range for Data:

Data Custodian: Univ. Wyoming, Laramie, WY

Remarks:

Reference: WMO PEP Report No. 21 (1980)

Project: EPOCS* (1980)

*Equatorial Pacific Ocean Climate Study

Date(s): Feb. - Apr., 1980

Location(s): Panama, Galapagos, Acapulco, and equatorial vicinities

Participating Aircraft: NOAA, (Lockheed WP-3D "Orion")

Number of Flights: 5 (See note 3)

Estimated Value of Flights for data on:

Supercooled LWC	Poor (See note 1)	Est. Max SLWC: ?
Snow	---	
Ice Particles	?	
Graupel	?	
Hail	---	
Rain	?	
Freezing Rain or Drizzle	---	

Cloud Physics Probes in Use:

JW LWC Meter	(1-45 μ m)	Inoperative (See note 1)
PMS FSSP	(3-45 ")	Yes (See note 2)
PMS 1D-C (200X)	(20-300 ")	No
PMS 2D-C	(25-800 ")	Yes
PMS 1D-P (200Y)	(0.3-4.5 mm)	No
PMS 2D-P	(0.2-6.4 mm)	Yes
Ice Particle Counter		No
Particle Replicator		Yes
Icing Rate Meter		No

Cloud Types Sampled: Cu, St, TCu

Altitude Range for Data: 0.6 - 21 k ft. (0.2 - 6.5 km) ASL

Data Custodian: NOAA/ERL, Boulder, Colorado. (Principal
Investigators: V. E. Derr and B. R. Bean)

Remarks: 1 - JW-LWC system was defective and no LWC data are available.

2 - FSSP generally undercounts. No strobes or probe activity rates are available.

3 - Probably only one flight had measurements above the freezing level, which was nominally at about 17 k ft. (5 km)

Reference: Derr and Gunter (1982)

Project: Cloud Seeding Experiments (1980)

Date(s): Feb. - Apr., 1980

Location(s): West Coast of Washington State

Participating Aircraft: Univ. Washington (Douglas B-23)

Number of Flights: 11

Estimated Value of Flights for data on:

Supercooled LWC	Mediocre	Est. Max SLWC: 0.5 g/m ³
Snow	Fair	
Ice Particles	Good	
Graupel	---	
Hail	---	
Rain	---	
Freezing Rain or Drizzle	---	

Cloud Physics Probes in Use:

JW LWC Meter	(1-45 μ m)	Yes
PMS ASSP	(3-45 ")	Yes
PMS 1D-C (200X)	(20-300 ")	Yes (See note 1)
PMS 2D-C	(25-800 ")	Yes (See note 1)
PMS 1D-P (200Y)	(0.3-4.5 mm)	Yes (See note 1)
PMS 2D-P	(0.2-6.4 mm)	Yes (See note 1)
Ice Particle Counter		Yes
Particle Replicator		No
Icing Rate Meter		No

Cloud Types Sampled: Sc, St, Ns, Cu, Ac
 Altitude Range for Data: 3-17 k ft. (1-5 km)
 Data Custodian: Univ. Washington, Seattle, Washington

Remarks: 1 - Frequent problems with PMS 1-D and 2-D probes.

Project: CYCLES* (1980)

*Cyclonic Extratropical Storms

Date(s): Feb., 1980

Location(s): Washington State coastline

Participating Aircraft: USAF/AFGL (Lockheed MC-130E)

Number of Flights: 6

Estimated Value of Flights for data on:

Supercooled LWC	OK Est. Max SLWC: 1 g/m ³
Snow	Excellent
Ice Particles	Good
Graupel	?
Hail	---
Rain	?
Freezing Rain or Drizzle	?

Cloud Physics Probes in Use:

JW LWC Meter	(1-45 μ m)	Yes
PMS FSSP or ASSP	(3-45 ")	Yes
PMS 1D-C (200X)	(20-300 ")	Yes
PMS 2D-C	(25-800 ")	Yes
PMS 1D-P (200Y)	(0.3-4.5 mm)	Yes
PMS 2D-P	(0.2-6.4 mm)	Yes
Ice Particle Counter		No
Particle Replicator		Yes
Icing Rate Meter		Yes

Cloud Types Sampled: Mostly wintertime wave cyclones in maritime air.
 Altitude Range for Data: ?
 Data Custodian: AFGL/LYC, Hanscom AFB, Massachusetts. (But funding will be required to prepare data for use outside AFGL.)

Remarks: Some of the Univ. Washington B-23 flights occurred at the same time as some of these AFGL flights. These B-23 flights are listed under "Cloud Seeding Experiments" on an accompanying page, and served dual purpose of CYCLES and cloud seeding experiments.

Reference: Barnes et al (1982)

Project: USAF/AFGL Aircraft Icing Project (1980)

Date(s): Jan. - May, Oct., Dec., 1980

Location(s): OH, IL, NC, WA, ME, NY, CO, WI, MI

Participating Aircraft: USAF/AFGL (Lockheed MC-130E)

Number of Flights: 14

Estimated Value of Flights for data on:

Supercooled LWC	OK	Est. Max SLWC: 1 G/M ³
Snow	Good	
Ice Particles	Good	
Graupel	?	
Hail	---	
Rain	?	
Freezing Rain or Drizzle	?	

Cloud Physics Probes in Use:

JW LWC Meter	(1-45 μ m)	Yes
PMS FSSP or ASSP	(3-45 ")	Yes
PMS 10-C (200X)	(20-300 ")	Yes
PMS 2D-C	(25-800 ")	Yes
PMS 1D-P (200Y)	(0.3-4.5 mm)	Yes
PMS 2D-P	(0.2-6.4 mm)	Yes
Ice Particle Counter		No
Particle Replicator		Yes
Icing Rate Meter		Yes

Cloud Types Sampled: Mostly winter cloud systems and snowstorms

Altitude Range for Data: 3-24 k ft. (1 - 7.5 km) ASL

Data Custodian: AFGL/LYC, Hanscom AFB, Massachusetts. (But funding will be required to prepare data for use outside AFGL.)

Remarks: Instrument problems occur on some flights.

Reference: Cohen (1983)

Project: SCPP* (1980)

*Sierra Cooperative Pilot Project

Date(s): Jan. - March, 1980

Location(s): California (windward Sierra mountains)

Participating Aircraft: Univ. Wyoming (Beechcraft BE-200, "King Air")

Number of Flights: 12

Estimated Value of Flights for data on:

Supercooled LWC	Good	Est. Max SLWC: 1.5 g/m ³
Snow	Good	
Ice Particles	Good	
Graupel	?	
Hail	---	
Rain	---	
Freezing Rain or Drizzle	---	

Cloud Physics Probes in Use:

JW LWC Meter	(1-45 μ m)	Yes
PMS FSSP	(3-45 ")	Yes
PMS 1D-C (200X)	(20-300 ")	No
PMS 2D-C	(25-800 ")	Yes
PMS 1D-P (200Y)	(0.3-4.5 mm)	No
PMS 2D-P	(0.2-6.4 mm)	Yes
Ice Particle Counter		No
Particle Replicator		Yes
-Icing Rate Meter		No

Cloud Types Sampled: Cu, TCu, Cb, As, Ns, Sc, St, and orographically assisted clouds.

Altitude Range for Data: 2-26 k ft. (0.6-8 km) ASL

Data Custodian: Bureau of Reclamation, Denver, Colorado

Reference: "Project Skywater Data Inventory", 1979-80 SCPP Season"

Project: SCPP (1980)

Date(s): Jan. - March, 1980

Location(s): California

Participating Aircraft: Aero Systems (Rockwell, "Aero Commander")

Number of Flights: 16

Estimated Value of Flights for data on:

Supercooled LWC	OK	Est. Max SLWC: ?
Snow	Poor	(See note 1)
Ice Particles	Poor	(See note 1)
Graupel	Poor	(See note 1)
Hail	---	
Rain	---	
Freezing Rain or Drizzle	---	

Cloud Physics Probes in Use:

JW LWC Meter	(1-45 μ m)	Yes
PMS FSSP or ASSP	(3-45 ")	No
PMS 1D-C (200X)	(20-300 ")	No
PMS 2D-C	(25-800 ")	No
PMS 1D-P (200Y)	(0.3-4.5 mm)	No
PMS 2D-P	(0.2-6.4 mm)	No
Ice Particle Counter		Yes (See note 1)
Particle Replicator		No
Icing Rate Meter		No

Cloud Types Sampled: Cu, Cb, TCu, Ns, and orographically assisted clouds.

Altitude Range for Data: 10-20 k ft. (3-6 km) ASL

Data Custodian: Bureau of Reclamation, Denver, Colorado

Remarks: 1 - No information available on particle size or shape.

Project: USAF/AFGL Aircraft Icing Project (1979)

Date(s): Dec., 1979

Location(s): WV, IL, MI

Participating Aircraft: USAF/AFGL (Lockheed MC-130E)

Number of Flights: 3

Estimated Value of Flights for data on:

Supercooled LWC	OK Est. Max SLWC: 1 g/m ³
Snow	Good
Ice Particles	Good
Graupel	?
Hail	---
Rain	?
Freezing Rain or Drizzle	?

Cloud Physics Probes in Use:

JW LWC Meter (1-45 μm)	Yes
PMS FSSP or ASSP (3-45 ")	Yes
PMS 1D-C (200X) (20-300 ")	Yes
PMS 2D-C (25-800 ")	Yes
PMS 1D-P (200Y) (0.3-4.5 mm)	Yes
PMS 2D-P (0.2-6.4 mm)	Yes
Ice Particle Counter	No
Particle Replicator	Yes
Icing Rate Meter	Yes

Cloud Types Sampled: Mostly winter cloud systems and snowstorms.

Altitude Range for Data: 4 - 16 k ft (1 - 5 km) ASL

Data Custodian: AFGL/LYC, Hanscom AFB, Massachusetts. (But will require funding to prepare data for use outside of AFGL.)

Remarks:

References: Cohen (1983); Glass and Grantham (1981)

Project: NOAA Ice Crystal Processes Program/Upslope Storms (1979)

Date(s): Dec., 1979

Location(s): Eastern Colorado

Participating Aircraft: NCAR (Beechcraft BE-80 "Queen Air")

Number of Flights: 3

Estimated Value of Flights for data on:

Supercooled LWC	? (See note 1)
	Est. Max SLWC: 0.5 g/m ³
Snow	Good
Ice Particles	Good
Graupel	---
Hail	---
Rain	---
Freezing Rain or Drizzle	---

Cloud Physics Probes in Use:

JW LWC Meter (1-45 μm)	?
PMS FSSP (3-45 ")	Yes
PMS 1D-C (200X) (20-300 ")	No
PMS 2D-C (25-800 ")	Yes
PMS 1D-P (200Y) (0.3-4.5 mm)	No
PMS 2D-P (0.2-6.4 mm)	No
Ice Particle Counter	No
Particle Replicator	No
Icing Rate Meter	No

Cloud Types Sampled: Upslope, cyclonic Sc

Altitude Range for Data: 5 - 11 k ft. (1.5 - 3.3 km) ASL

Data Custodian: NOAA/ERL, Boulder, Colorado

Remarks: 1 - Have FSSP data only, no JW for LWC comparisons?

Reference: Riehl and Reinking (1981)

Project: COSE*-II (1979)

*Colorado Orographic Seeding Experiment - II

Date(s): Nov. - Dec., 1979

Location(s): Colorado (mountains)

Participating Aircraft: NCAR (Beechcraft BE-80 "Queen Air")

Number of Flights: 7

Estimated Value of Flights for data on:

Supercooled LWC	OK	Est. Max SLWC: ?
Snow	Good	
Ice Particles	Good	
Graupel	?	
Hail	---	
Rain	?	
Freezing Rain or Drizzle	?	

Cloud Physics Probes in Use:

JW LWC Meter	(1-45 μ m)	Yes
PMS FSSP	(3-45 ")	Yes
PMS 1D-C (200X)	(20-300 ")	No
PMS 2D-C	(25-800 ")	Yes
PMS 1D-P (200Y)	(0.3-4.5 mm)	No
PMS 2D-P	(0.2-6.4 mm)	No
Ice Particle Counter		No
Particle Replicator		No
Icing Rate Meter		No

Cloud Types Sampled: Orographically assisted storm systems.
 Altitude Range for Data: ?
 Data Custodian: Colorado State Univ., Ft. Collins, Colorado
 (Prof. L. O. Grant, Principal Investigator)

Remarks:

Reference: Lee (1984)

Project: COSE-II (1979)

Date(s): Nov. - Dec., 1979

Location(s): Colorado (mountains)

Participating Aircraft: Colorado International Corp. (Lear Jet)

Number of Flights: 5

Estimated Value of Flights for data on:

Supercooled LWC	?	(See note 1) Est. Max SLWC: ?
Snow	Good	
Ice Particles	Good	
Graupel	?	
Hail	---	
Rain	?	
Freezing Rain or Drizzle	?	

Cloud Physics Probes in Use:

JW LWC Meter	(1-45 μ m)	Yes
PMS FSSP or ASSP	(3-45 ")	No (See note 1)
PMS 1D-C (200X)	(20-300 ")	No
PMS 2D-C	(25-800 ")	Yes
PMS 1D-P (200Y)	(0.3-4.5 mm)	No
PMS 2D-P	(0.2-6.4 mm)	No
Ice Particle Counter		?
Particle Replicator		No
Icing Rate Meter		No

Cloud Types Sampled: Orographically assisted storm systems.
 Altitude Range for Data: ?
 Data Custodian: Colorado State Univ., Ft. Collins, Colorado

Remarks: 1 - For LWC have JW only, no FSSP for backup.

Reference: Lee (1984)

Project: NOAA/NHRL Hurricane Flights (1979)

Date(s): Aug. - Sept., 1979

Location(s): Caribbean, Gulf of Mexico

Participating Aircraft: NOAA/NHRL (Lockheed C-130B)

Number of Flights: 1 (with cloud data above the 0°C level)
7 (with cloud data below the 0°C level)

Estimated Value of Flights for data on:

Supercooled LWC	Fair (No FSSP comparison)
	Est. Max SLWC: 2-3 G/M ³
Snow	?
Ice Particles	Good
Graupel	Good
Hail	---
Rain	Good
Freezing Rain or Drizzle	---

Cloud Physics Probes in Use:

JW LWC Meter (1-45 μm)	Yes
PMS FSSP or ASSP (3-45 ")	No
PMS 1D-C (200X) (20-300 ")	No
PMS 2D-C (25-800 ")	No
PMS 1D-P (200Y) (0.3-4.5 mm)	No
PMS 2D-P (0.2-6.4 mm)	Yes
Ice Particle Counter	Yes
Particle Replicator (foil and Formvar)	Yes
Icing Rate Meter	No

Cloud Types Sampled: Hurricanes
Altitude Range for Data: 2-20 k ft. (0.6-6 km) ASL
Data Custodian: NOAA/NHRL, Coral Gables, Florida

Remarks:

Project: FACE*-II (1979)

*Florida Area Cumulus Experiment

Date(s): July - Aug., 1979

Location(s): Florida

Participating Aircraft: Aero Systems, Inc. (North American Rockwell, "Aero Commander")

Number of Flights: 19

Estimated Value of Flights for data on:

Supercooled LWC	OK (See note 1)
	Est. Max SLWC: 2 g/m ³
Snow	?
Ice Particles	OK
Graupel	OK
Hail	?
Rain	---
Freezing Rain or Drizzle	---

Cloud Physics Probes in Use:

JW LWC Meter (1-45 μm)	Yes
PMS FSSP or ASSP (3-45 ")	No (See note 1)
PMS 1D-C (200X) (20-300 ")	Yes (See note 2)
PMS 2D-C (25-800 ")	No
PMS 1D-P (200Y) (0.3-4.5 mm)	Yes (See note 2)
PMS 2D-P (0.2-6.4 mm)	No
Ice Particle Counter	Yes
Particle Replicator	Yes (See note 3)
Icing Rate Meter	No

Cloud Types Sampled: Cu
Altitude Range for Data: -10°C level (15-20 k ft.) (4.5-6 km) ASL
Data Custodian: NOAA/ERL, Boulder, Colorado. (But data tapes may not be available for the first third of the project.)

Remarks: 1 - No FSSP for comparison to JW LWCs.

2 - PMS probes had some misalignment problems during July and may be undercounting in August (see pg. 45 of Ref. 1).

3 - There were some problems with the replicator.

References: "1979 FACE Operational Summary and Data Inventory"
Jordan, Hallett, and Reinking (1981)

Project: TRIP* (1979)

*Thunderstorm Research International Program

Date(s): July, Aug., 1979

Location(s): New Mexico

Participating Aircraft: NCAR/NOAA (Schweizer 2-32 sailplane)

Number of Flights: 7

Estimated Value of Flights for data on:

Supercooled LWC	Good	Est. Max SLWC: 1.8 g/m ³
Snow	---	
Ice Particles	OK	
Graupel	OK	
Hail	---	
Rain	---	
Freezing Rain or Drizzle	---	

Cloud Physics Probes in Use:

JW LWC Meter	(1-45 μ m)	Yes
PMS FSPP or ASSP	(3-45 ")	Yes
PMS 1D-C (200X)	(20-300 ")	No
PMS 2D-C	(25-800 ")	No
PMS 1D-P (200Y)	(0.3-4.5 mm)	No
PMS 2D-P	(0.2-6.4 mm)	No
Ice Particle Counter		No
Particle Replicator ("Cannon" camera)		Yes
Icing Rate Meter		No

Cloud Types Sampled: Cu, Cg, Cb

Altitude Range for Data: 13-26 k ft. (4-8 km) ASL

Data Custodian: NCAR Convective Storms Division, Boulder, Colorado

Remarks: 1 - Copies of archived data tapes may be difficult to obtain because of format incompatibilities between the original tapes and the new computer system installed at NCAR in the meantime.

Project: SMONEX* (1979)

*Summer Monsoon Experiment

Date(s): June - July, 1979

Location(s): Arabian Sea, Bay of Bengal

Participating Aircraft: NOAA (Lockheed WP-3D)

Number of Flights: 11

Estimated Value of Flights for data on:

Supercooled LWC	OK	Est. Max SLWC: ?
Snow	OK	
Ice Particles	Good	
Graupel	Good	
Hail	---	
Rain	OK	
Freezing Rain or Drizzle	---	

Cloud Physics Probes in Use:

JW LWC Meter	(1-45 μm)	Yes
PMS FSSP	(3-45 ")	Yes (See note 1)
PMS 1D-C (200X)	(20-300 ")	No
PMS 2D-C	(25-800 ")	Yes
PMS 1D-P (200Y)	(0.3-4.5 mm)	No
PMS 2D-P	(0.2-6.4 mm)	Yes
Ice Particle Counter		No
Particle Replicator		No
Icing Rate Meter		No

Cloud Types Sampled: As, Cs, St, Cu, Ci, Cb
 Altitude Range for Data: 20 - 30 k ft. (6 - 9 km) ASL
 Data Custodian: NCAR/RAF, Boulder, Colorado

Remarks: 1 - No strobes or probe activity rates are available.

Reference: Fein and Kuettner (1980)

Project: SMONEX (1979)

Date(s): June, July, 1979

Location(s): Arabian Sea, Bay of Bengal

Participating Aircraft: NCAR (Lockheed "Electra")

Number of Flights: 12

Estimated Value of Flights for data on:

Supercooled LWC	OK	Est. Max SLWC:
Snow	---	
Ice Particles	?	
Graupel	?	
Hail	---	
Rain	?	
Freezing Rain or Drizzle	---	

Cloud Physics Probes in Use:

JW LWC Meter	(1-45 μm)	Yes
PMS FSSP or ASSP	(3-45 ")	Yes
PMS 1D-C (200X)	(20-300 ")	Yes
PMS 2D-C	(25-800 ")	No
PMS 1D-P (200Y)	(0.3-4.5 mm)	Yes
PMS 2D-P	(0.2-6.4 mm)	No
Ice Particle Counter		No
Particle Replicator		No
Icing Rate Meter		No

Cloud Types Sampled:
 Altitude Range for Data:
 Data Custodian: NCAR/RAF, Boulder, Colorado

Remarks:

Project: HIPLEX* (1979)

*High Plains Cooperative Program

Date(s): May - July, 1979

Location(s): Montana

Participating Aircraft: Univ. Wyoming, (Beechcraft BE-200T, "King Air")

Number of Flights: 37

Estimated Value of Flights for data on:

Supercooled LWC	Good	Est. Max SLWC: 1 g/m ³
Snow	---	
Ice Particles	Good	
Graupel	?	
Hail	---	
Rain	---	
Freezing Rain or Drizzle	---	

Cloud Physics Probes in Use:

JW LWC Meter	(1-45 μ m)	Yes
PMS FSSP or ASSP	(3-45 ")	Yes
PMS 1D-C (200X)	(20-300 ")	Yes
PMS 2D-C	(25-800 ")	Yes
PMS 1D-P (200Y)	(0.3-4.5 mm)	No
PMS 2D-P	(0.2-6.4 mm)	Yes
Ice Particle Counter		No
Particle Replicator		Yes
Icing Rate Meter		No

Cloud Types Sampled: Cu, TCU, Sc, TRW
 Altitude Range for Data: 10-25 k ft. (3-7.5 km) ASL
 Data Custodian: Bureau of Reclamation, Boulder, Colorado

Remarks: Aircraft operated mainly at mid cloud level

Reference: "Project Skywater Data Inventory: 1979 HIPLEX Season"

Project: HIPLEX (1979)

Date(s): May - July, 1979

Location(s): Montana

Participating Aircraft: Colorado International Corporation Learjet 23)

Number of Flights: 38

Estimated Value of Flights for data on:

Supercooled LWC	Good? (See note 2)
	Est. Max SLWC: 1 g/m ³
Snow	Poor
Ice Particles	Good
Graupel	Poor
Hail	---
Rain	---
Freezing Rain or Drizzle	---

Cloud Physics Probes in Use:

JW LWC Meter	(1-45 μ m)	Yes
PMS FSSP or ASSP	(3-45 ")	No (See note 2)
PMS 1D-C (200X)	(20-300 ")	No
PMS 2D-C	(25-800 ")	Yes
PMS 1D-P (200Y)	(0.3-4.5 mm)	No
PMS 2D-P	(0.2-6.4 mm)	No
Ice Particle Counter		Yes
Particle Replicator		No
Icing Rate Meter		No

Cloud Types Sampled: TCU
 Altitude Range for Data: 15 - 20 k ft. (4.5 - 6 km) ASL
 Data Custodian: Bureau of Reclamation, Denver, Colorado

Remarks: 1 - Aircraft operated as seeding and cloud top data aircraft.
 Seeding done at -10°C level.

2 - No FSSP for dropsize or LWC comparison.

Project: HIPLEX (1979)

Date(s): July, 1979

Location(s): Montana

Participating Aircraft: Canadian AES/NAE (DeHavilland DH6, "Twin Otter")

Number of Flights: 16

Estimated Value of Flights for data on:

Supercooled LWC	?	(See note 1) Est. Max SLWC: ?
Snow	---	
Ice Particles	?	
Graupel	?	
Hail	---	
Rain	---	
Freezing Rain or Drizzle	---	

Cloud Physics Probes in Use:

JW LWC Meter	(1-45 μ m)	Yes
PMS FSSP	(3-45 ")	Yes
PMS 1D-C (200X)	(20-300 ")	Yes
PMS 2D-C	(25-800 ")	Yes
PMS 1D-P (200Y)	(0.3-4.5 mm)	Yes
PMS 2D-P	(0.2-6.4 mm)	Yes
Ice Particle Counter		Yes
Particle Replicator		Yes
Icing Rate Meter		No

Cloud Types Sampled: Cu, TCu

Altitude Range for Data: 4 - 18 k ft. (1 - 5.5 km) ASL

Data Custodian: Bureau of Reclamation, Denver, Colorado

Remarks: 1 - Aircraft operated mostly near cloud base. May have been a few higher flite levels, but don't know if any were above freezing level.

Project: HIPLEX (1979)

Date(s): June - July, 1979

Location(s): Texas

Participating Aircraft: Colorado River Municipal Water District
(Piper PA31-P, "Navajo")

Number of Flights: 8

Estimated Value of Flights for data on:

Supercooled LWC	OK (See note 2) Est. Max SLWC: ?
Snow	---
Ice Particles	Fair (See note 3)
Graupel	---
Hail	---
Rain	---
Freezing Rain or Drizzle	---

Cloud Physics Probes in Use:

JW LWC Meter	(1-45 μ m)	Yes (See note 2)
PMS FSSP or ASSP	(3-45 ")	No (See note 3)
PMS 1D-C (200X)	(20-300 ")	No
PMS 2D-C	(25-800 ")	No
PMS 1D-P (200Y)	(0.3-4.5 mm)	No
PMS 2D-P	(0.2-6.4 mm)	No
Ice Particle Counter		Yes (See note 3)
Particle Replicator		No
Icing Rate Meter		No

Cloud Types Sampled: Ac, Cu

Altitude Range for Data: -100

Data Custodian: Bureau of Reclamation, Denver, Colorado

Remarks: 1 - Aircraft operated mainly at the -100 level (if there was one) for cloud seeding and data collection.

2 - Two types of hot wire sensors were in use--the JW and the "Merceret-Schricker"

Reference: Alexander and Riggio (1980)

Project: HIPLEX (1979)

Date(s): May - July, 1979

Location(s): Texas

Participating Aircraft: MRI (Piper PA-32 "Navajo")

Number of Flights: 14

Estimated Value of Flights for data on:

Supercooled LWC	OK (See note 1) Est. Max SLWC: ?
Snow	---
Ice Particles	OK
Graupel	?
Hail	---
Rain	Good
Freezing Rain or Drizzle	---

Cloud Physics Probes in Use:

JW LWC Meter	(1-45 μm)	Yes
PMS ASSP	(3-45 ")	Yes
PMS 1D-C (200X)	(20-300 ")	Yes
PMS 2D-C	(25-800 ")	Yes
PMS 1D-P (200Y)	(0.3-4.5 mm)	Yes
PMS 2D-P	(0.2-6.4 mm)	No
Ice Particle Counter		Yes
Particle Replicator		Yes
Icing Rate Meter		No

Cloud Types Sampled: Ac, Cu

Altitude Range for Data: ?

Data Custodian: Bureau of Reclamation, Denver, Colorado

Remarks: Aircraft operated primarily near cloud base. Don't know how often flights went above the freezing level.

Reference: Alexander and Riggio (1980)

Project: HIPLEX (1979) (Extended Area Effects Exploratory Exp't)

Date(s): August, 1979

Location(s): Montana, ND, SD

Participating Aircraft: Colorado Int'l Corp. (Learjet 23)

Number of Flights: 8

Estimated Value of Flights for data on:

Supercooled LWC	?	(See note 1) Est. Max SLWC: ?
Snow	?	
Ice Particles	Good	
Graupel	?	
Hail	---	
Rain	---	
Freezing Rain or Drizzle	---	

Cloud Physics Probes in Use:

JW LWC Meter	(1-45 μm)	Yes
PMS FSSP or ASSP	(3-45 ")	No (See note 1)
PMS 1D-C (200X)	(20-300 ")	No
PMS 2D-C	(25-800 ")	Yes
PMS 1D-P (200Y)	(0.3-4.5 mm)	No
PMS 2D-P	(0.2-6.4 mm)	No
Ice Particle Counter		Yes
Particle Replicator		No
Icing Rate Meter		No

Cloud Types Sampled: Anvil cirrus, Cb, TCu?

Altitude Range for Data: 20 k ft. (6 km) ASL

Data Custodian: Univ. North Dakota, Grand Forks, North Dakota

Remarks: 1 - No FSSP for dropsize or LWC comparisons.

Project: SESAME* (1979)

*Severe Environmental Storms and Mesoscale Experiment

Date(s): April - June, 1979

Location(s): Oklahoma

Participating Aircraft: South Dakota Schl. Mines & Tech. (North American, T-28)

Number of Flights: 12

Estimated Value of Flights for data on:

Supercooled LWC	Good (See note 2)
	Est. Max SLWC: (See note 3)
Snow	?
Ice Particles	OK
Graupel	OK
Hail	Good
Rain	---
Freezing Rain or Drizzle	---

Cloud Physics Probes in Use:

JW LWC Meter (1-45 μ m)	Yes (See note 2)
PMS FSSP (3-45 ")	Yes (See note 2)
PMS 1D-C (200X) (20-300 ")	No
PMS 2D-C (25-800 ")	Yes
PMS 1D-P (200Y) (0.3-4.5 mm)	No
PMS 2D-P (0.2-6.4 mm)	No
Ice Particle Counter	No
Particle Replicator	Yes
Icing Rate Meter	No
IAS Laser Hail Spectrometer (5-50 mm)	Yes

Cloud Types Sampled: Cb

Altitude Range for Data: Max 25 k ft. (7.5 km) ASL

Data Custodian: NCAR Convective Storms Division, Boulder, Colorado

Remarks: 1 - Aircraft used mainly for mature storm penetrations for data on LWC, hail, and other hydrometeors.

2 - JW-LWC is consistently 50% less than FSSP.

3 - Max LWC = 6 g/m³ from FSSP, 2 g/m³ from JW

Reference: 1. "SESAME 1979 Data User's Guide"
2. Heymsfield and Hjelmfelt (1984)

Project: SESAME (1979)

Date(s): June, 1979

Location(s): Oklahoma

Participating Aircraft: NCAR (Beechcraft BE-80 "Queen Air")

Number of Flights: 2

Estimated Value of Flights for data on:

Supercooled LWC	Poor (See note 1) Est. Max SLWC: ?
Snow	---
Ice Particles	---
Graupel	---
Hail	---
Rain	---
Freezing Rain or Drizzle	---

Cloud Physics Probes in Use:

JW LWC Meter (1-45 μ m)	Yes
PMS FSSP or ASSP (3-45 ")	No (See note 1)
PMS 1D-C (200X) (20-300 ")	No
PMS 2D-C (25-800 ")	No
PMS 1D-P (200Y) (0.3-4.5 mm)	No
PMS 2D-P (0.2-6.4 mm)	No
Ice Particle Counter	No
Particle Replicator	No
Icing Rate Meter	No

Cloud Types Sampled: TCu

Altitude Range for Data:

Data Custodian: NCAR Convective Storms Division, Boulder, Colorado

Remarks: 1 - No FSSP for dropsize or for LWC comparisons.

Project: SESAME (1979)

Date(s): May, 1979

Location(s): Oklahoma

Participating Aircraft: NCAR (North American Rockwell N265, "Sabreliner")

Number of Flights: 3

Estimated Value of Flights for data on:

Supercooled LWC	Poor (See note 1) Est. Max SLWC: ?
Snow	?
Ice Particles	?
Graupel	?
Hail	---
Rain	---
Freezing Rain or Drizzle	---

Cloud Physics Probes in Use:

JW LWC Meter (1-45 μ m)	No (See note 1)
PMS FSSP or ASSP (3-45 ")	} Two of these were in use but Data User's Guide doesn't indicate which two.
PMS 1D-C (200X) (20-300 ")	
PMS 2D-C (25-800 ")	
PMS 1D-P (200Y) (0.3-4.5 mm)	
PMS 2D-P (0.2-6.4 mm)	
Ice Particle Counter	No
Particle Replicator	No
Icing Rate Meter	No

Cloud Types Sampled: TCu
 Altitude Range for Data: 30 k ft. (9 km) ASL
 Data Custodian: NCAR Convective Storms Division, Boulder, Colorado

Remarks: 1 - No JW LWC meter in use.

Project: USAF/AFGL LSCS* (1979)

*Large Scale Cloud Systems

Date(s): April and August, 1979

Location(s): WA, CA, MA, TX, IL

Participating Aircraft: USAF/AFGL (Lockheed MC-130E)

Number of Flights: 6

Estimated Value of Flights for data on:

Supercooled LWC	OK Est. Max SLWC: ?
Snow	Excellent
Ice Particles	Good
Graupel	?
Hail	---
Rain	Good
Freezing Rain or Drizzle	?

Cloud Physics Probes in Use:

JW LWC Meter (1-45 μ m)	Yes
PMS FSSP or ASSP (3-45 ")	Yes
PMS 1D-C (200X) (20-300 ")	Yes
PMS 2D-C (25-800 ")	Yes
PMS 1D-P (200Y) (0.3-4.5 mm)	Yes
PMS 2D-P (0.2-6.4 mm)	Yes
Ice Particle Counter	No
Particle Replicator	Yes
Icing Rate Meter	No

Cloud Types Sampled: Ns, Ci
 Altitude Range for Data: Up to 29 k ft. (9 km) ASL
 Data Custodian: AFGL/LYC, Hanscom AFB, Massachusetts. (But will require funding to prepare data for use outside AFGL.)

Remarks:

Reference: Barnes et al (1982)

Project: PEP* (1979)

*Precipitation Enhancement Project

Date(s): March - May, 1979

Location(s): Spain

Participating Aircraft: Univ. Wyoming (Beechcraft BE-80 "Queen Air")

Number of Flights: 27

Estimated Value of Flights for Data on:

Supercooled LWC	Good	Est. Max SLWC: ?
Snow	?	
Ice Particles	Good	
Graupel	?	
Hail	---	
Rain	?	
Freezing Rain or Drizzle	---	

Cloud Physics Probes in Use:

JW LWC Meter	(1-45 μ m)	Yes and King-CSIRO probe
PMS ASSP	(2-30 ")	Yes
PMS 1D-C (200X)	(20-300 ")	No
PMS 2D-C	(25-800 ")	Yes
PMS 1D-P (200Y)	(0.3-4.5 mm)	No
PMS 2D-P	(0.2-6.4 mm)	No
Ice Particle Counter	(100 m)	No
Particle Replicator		Yes
Icing Rate Meter		No

Cloud Types Sampled:

Altitude Range for Data:

Data Custodian: Univ. Wyoming, Laramie, WY

Remarks:

Reference: WMO PEP Report No. 15 (1980)

Project: PEP (1979)

Date(s): March - April, 1979

Location(s): Spain

Participating Aircraft: L.A.M.P./Univ. Clermont II (Douglas DC-7)

Number of Flights: 13

Estimated Value of Flights for Data on:

Supercooled LWC	Good	Est. Max SLWC: 2 g/m ³
Snow	?	
Ice Particles	Good	
Graupel	?	
Hail	---	
Rain	?	
Freezing Rain or Drizzle	---	

Cloud Physics Probes in Use:

JW LWC Meter	(1-45 μ m)	Yes
PMS FSSP	(2-30 ")	Yes
PMS 1D-C (200X)	(20-300 ")	Yes
PMS 2D-C	(25-800 ")	No
PMS 1D-P (200Y)	(0.3-4.5 mm)	Yes
PMS 2D-P	(0.2-6.4 mm)	No
Ice Particle Counter	(100 m)	No
Particle Replicator		No
Icing Rate Meter		Yes

Cloud Types Sampled: Sc, Cu cong., Cb

Altitude Range for Data:

Data Custodian: LAMP, Univ. Clermont II, 63170 Aubiere, France

Remarks:

Reference: WMO PEP Report No. 15 (1981)

Project: Icing Research Flights (1979)

Date(s): March, 1979

Location(s): Great Lakes vicinity

Participating Aircraft: NRL, (Lockheed EC-121 "Super Constellation")

Number of Flights: 4

Estimated Value of Flights for data on:

Supercooled LWC	OK	Est. Max SLWC: 0.5 g/m ³
Snow	---	
Ice Particles	---	
Graupel	---	
Hail	---	
Rain	---	
Freezing Rain or Drizzle	---	

Cloud Physics Probes in Use:

JW LWC Meter	(1-45 μ m)	Yes (See note 1)
PMS ASSP	(3-45 ")	Yes (See note 1)
PMS 1D-C (200X)	(20-300 ")	No
PMS 2D-C	(25-800 ")	No
PMS 1D-P (200Y)	(0.3-4.5 mm)	No
PMS 2D-P	(0.2-6.4 mm)	No
Ice Particle Counter		No
Particle Replicator		No
Icing Rate Meter		No

Cloud Types Sampled: St, Sc

Altitude Range for Data: 3-7 k ft.

Data Custodian: NRL, Washington, DC. (But funding will be required to prepare data for use outside of NRL.)

Remarks: 1 - Some instrument problems.

Reference: Jeck (1980)

Project: Univ. Washington CYCLES* (1979)

*Cyclonic Extratropical Storms

Date(s): Feb. - Mar., Nov. - Dec., 1979

Location(s): West coast of Washington State and offshore

Participating Aircraft: Univ. Washington (Douglas B-23)

Number of Flights: 14

Estimated Value of Flights for data on:

Supercooled LWC	Good	Est. Max SLWC: 0.5 g/m ³
Snow	Good	
Ice Particles	Good	
Graupel	Good	
Hail	---	
Rain	Fair	
Freezing Rain or Drizzle	---	

Cloud Physics Probes in Use:

JW LWC Meter	(1-45 μ m)	Yes
PMS ASSP	(3-45 ")	Yes
PMS 1D-C (200X)	(20-300 ")	Yes
PMS 2D-C	(25-800 ")	Yes
PMS 1D-P (200Y)	(0.3-4.5 mm)	Yes
PMS 2D-P	(0.2-6.4 mm)	No
Ice Particle Counter		Yes
Particle Replicator		No
Icing Rate Meter		No

Cloud Types Sampled: As, Ns, St, Sc, Cu, Cu Cong, C1

Altitude Range for Data: 3-24 k ft. (1-7.5 km) ASL

Data Custodian: Univ. Washington, Seattle, Washington

Remarks: 1 - Occasional malfunctions of various PMS probes.

Project: CYCLES (1979)

Date(s): Feb. - Mar., 1979

Location(s): Washington State coastline

Participating Aircraft: USAF/AFGL (Lockheed MC-130E)

Number of Flights: 12

Estimated Value of Flights for data on:

Supercooled LWC	OK	Est. Max SLWC: 1 g/m ³
Snow	Excellent	
Ice Particles	Good	
Graupel	?	
Hail	---	
Rain	?	
Freezing Rain or Drizzle	?	

Cloud Physics Probes in Use:

JW LWC Meter	(1-45 μ m)	Yes
PMS FSSP or ASSP	(3-45 ")	Yes
PMS 1D-C (200X)	(20-300 ")	Yes
PMS 2D-C	(25-800 ")	Yes
PMS 1D-P (200Y)	(0.3-4.5 mm)	Yes
PMS 2D-P	(0.2-6.4 mm)	Yes
Ice Particle Counter		No
Particle Replicator		Yes
Icing Rate Meter		No

Cloud Types Sampled: Mostly wintertime wave cyclones in maritime air.

Altitude Range for Data: ?

Data Custodian: AFGL/LYC, Hanscom AFB, Massachusetts. (But will require funding to prepare data for use outside AFGL.)

Remarks:

Reference: Barnes et al (1982)

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Project: NOAA/NHRL Hurricane Flights (1979)

Date(s): Feb., March, 1979

Location(s): South Pacific near Australia

Participating Aircraft: NOAA/NHRL (Lockheed WP-3D)

Number of Flights: 3 (with cloud data above the 0°C level)
4 (at 1500 ft (0.5 km))

Estimated Value of Flights for data on:

Supercooled LWC	Fair (See notes 1, 2)
	Est. Max SLWC: 2-3 g/m ³
Snow	?
Ice Particles	Fair (See note 3)
Graupel	Fair (See note 3)
Hail	---
Rain	---
Freezing Rain or Drizzle	---

Cloud Physics Probes in Use:

JW LWC Meter	(1-45 μm)	Yes
PMS FSSP	(3-45 ")	Yes (See note 1)
PMS 1D-C (200X)	(20-300 ")	No
PMS 2D-C	(25-800 ")	Yes
PMS 1D-P (200Y)	(0.3-4.5 mm)	No
PMS 2D-P	(0.2-6.4 mm)	Yes
Ice Particle Counter		Yes
Particle Replicator (formvar, foil)		Yes
Icing Rate Meter		No

Cloud Types Sampled: Hurricane

Altitude Range for Data: 2-24 k ft. (0.6-7 km) ASL

Data Custodian: NOAA/NHRL, Coral Gables, Florida

Remarks: 1 - FSSP data have not been corrected for anything; probe reportedly gives low concentrations and 1/10 to 1/2 the JW-LWC. No strobes or probe activity rates are available.

2 - Hurricanes are reportedly well-glaciated above the 0°C level, so not much SLWC is found except in convective bands where SLWC can reach 2-3 g/m³ sometimes.

3 - PMS 2D-P is inoperative. Have ice particle counter and Formvar data only.

Reference: Friedman et al (1982)

Project: Cloud Seeding Experiments (1979)

Date(s): Feb., and Nov. - Dec., 1979

Location(s): West coast of Washington State

Participating Aircraft: Univ. Washington (Douglas B-23)

Number of Flights: 4

Estimated Value of Flights for data on:

Supercooled LWC	Good	Est. Max SLWC: 0.5 g/m ³
Snow	Fair	
Ice Particles	Good	
Graupel	---	
Hail	---	
Rain	Fair	
Freezing Rain or Drizzle	---	

Cloud Physics Probes in Use:

JW LWC Meter	(1-45 μm)	Yes
PMS ASSP	(3-45 ")	Yes
PMS 1D-C (200X)	(20-300 ")	Yes
PMS 2D-C	(25-800 ")	Yes
PMS 1D-P (200Y)	(0.3-4.5 mm)	Yes
PMS 2D-P	(0.2-6.4 mm)	No
Ice Particle Counter		Yes
Particle Replicator		No
Icing Rate Meter		No

Cloud Types Sampled: St, Sc, As, Cu

Altitude Range for Data: 3-16 k ft. (1-5 km) ASL

Data Custodian: Univ. Washington, Seattle, Washington

Remarks: May be one good case of mixed phase conditions in maritime Cu.

Project: SCPP* (1978-79)

*Sierra Cooperative Pilot Project

Date(s): Jan. - March, 1979

Location(s): California (Windward Sierra Mountains)

Participating Aircraft: Univ. Wyoming (Beechcraft BE-200 "King Air")

Number of Flights: 26

Estimated Value of Flights for data on:

Supercooled LWC	Good	Est. Max SLWC: 1 g/m ³
Snow	?	
Ice Particles	Good	
Graupel	OK	
Hail	---	
Rain	---	
Freezing Rain or Drizzle	---	

Cloud Physics Probes in Use:

JW LWC Meter (1-45 μ m)	Yes
PMS FSSP or ASSP (3-45 ")	Yes
PMS 1D-C (200X) (20-300 ")	Yes
PMS 2D-C (25-800 ")	Yes
PMS 1D-P (200Y) (0.3-4.5 mm)	No
PMS 2D-P (0.2-6.4 mm)	Yes
Ice Particle Counter	No
Particle Replicator	Yes
Icing Rate Meter	No

Cloud Types Sampled: Cu, Sc, Orographic
 Altitude Range for Data: 5-15 k ft. (?) (1.5-4.5 km) ASL
 Data Custodian: Bureau of Reclamation, Denver, Colorado

Remarks:

Reference: "Sierra Coop. Pilot Project 1978-79 Data Inventory"

Project: SCPP (1978-79)

Date(s): Feb. - March, 1979

Location(s): California (Windward Sierra Mountains)

Participating Aircraft: Aero Systems, Inc. (No. American Rockwell, "Aero Commander")

Number of Flights: 17

Estimated Value of Flights for data on:

Supercooled LWC	OK (See note 1)	Est. Max SLWC: ?
Snow	Poor	
Ice Particles	Fair (See note 2)	
Graupel	Fair (See note 2)	
Hail	---	
Rain	---	
Freezing Rain or Drizzle	---	

Cloud Physics Probes in Use:

JW LWC Meter (1-45 μ m)	Yes
PMS FSSP or ASSP (3-45 ")	No (See note 1)
PMS 1D-C (200X) (20-300 ")	No
PMS 2D-C (25-800 ")	No
PMS 1D-P (200Y) (0.3-4.5 mm)	No
PMS 2D-P (0.2-6.4 mm)	No
Ice Particle Counter	Yes (See note 2)
Particle Replicator	No
Icing Rate Meter	No

Cloud Types Sampled: Cu, Sc, Oro.
 Altitude Range for Data: ?
 Data Custodian: Bureau of Reclamation, Denver, Colorado

Remarks: 1 - No FSSP for droplet sizes or LWC comparisons.

2 - No information on particle sizes or shapes.

Project: COSE*-I (1979)

*Colorado Orographic Seeding Experiment

Date(s): Jan. - Mar., 1979

Location(s): Colorado (mountains)

Participating Aircraft: Colorado International Corp. (Piper PA-31 "Navajo")

Number of Flights: 5

Estimated Value of Flights for data on:

Supercooled LWC	?	Est. Max SLWC: ?
Snow		
Ice Particles		
Graupel		
Hail		
Rain		
Freezing Rain or Drizzle		

Cloud Physics Probes in Use:

JN LWC Meter	{ 1-45 μ m }	
PMS FSSP or ASSP	{ 3-45 " }	
PMS 1D-C (200X)	(20-300 ")	
PMS 2D-C	(25-800 ")	?
PMS 1D-P (200Y)	(0.3-4.5 mm)	
PMS 2D-P	(0.2-6.4 mm)	?
Ice Particle Counter		
Particle Replicator		
Icing Rate Meter		

Cloud Types Sampled: Orographically assisted storm systems.

Altitude Range for Data: ?

Data Custodian: Colorado State Univ., Ft. Collins, Colorado

Remarks:

Project: USAF/AFGL Cirrus Studies

Date(s): Jan. - Feb., 1979

Location(s): NM, CO, TX, CA

Participating Aircraft: USAF/AFGL (Lockheed MC-130E)

Number of Flights: 7

Estimated Value of Flights for data on:

Supercooled LWC	---
Snow	---
Ice Particles	Good
Graupel	---
Hail	---
Rain	---
Freezing Rain or Drizzle	---

Cloud Physics Probes in Use:

JN LWC Meter	{ 1-45 μ m }	Yes
PMS FSSP or ASSP	{ 3-45 " }	Yes
PMS 1D-C (200X)	(20-300 ")	Yes
PMS 2D-C	(25-800 ")	Yes
PMS 1D-P (200Y)	(0.3-4.5 mm)	Yes
PMS 2D-P	(0.2-6.4 mm)	Yes
Ice Particle Counter		Inoperative
Particle Replicator		Yes
Icing Rate Meter		No

Cloud Types Sampled: Cirrus

Altitude Range for Data: ?

Data Custodian: AFGL/LYC, Hanscom AFB, Massachusetts. (But will require funding to prepare data for use outside of AFGL.)

Remarks:

References: Barnes et al (1982), Cohen (1981), and Varley et al (1980)

Project: WMONEX* (1978)

*Winter Monsoon Experiment

Date(s): December, 1978

Location(s): South China Sea, Java Sea (Malaysia)

Participating Aircraft: NOAA (Lockheed WP-3D)

Number of Flights: 8

Estimated Value of Flights for data on:

Supercooled LWC	?	Est. Max SLWC: ?
Snow	---	
Ice Particles	Good	
Graupel	Good	
Hail	Some	
Rain	?	
Freezing Rain or Drizzle	---	

Cloud Physics Probes in Use:

JW LWC Meter	(1-45 μ m)	Yes
PMS FSSP	(3-45 ")	Yes (See note 1)
PMS 1D-C (200X)	(20-300 ")	No
PMS 2D-C	(25-800 ")	Yes
PMS 1D-P (200Y)	(0.3-4.5 mm)	No
PMS 2D-P	(0.2-6.4 mm)	Yes
Ice Particle Counter		No
Particle Replicator		No
Icing Rate Meter		No

Cloud Types Sampled:

Altitude Range for Data:

Data Custodian: Dept. of Atm. Sci., Univ. Washington, Seattle, Washington

Remarks: 1 - No strobes or probe activity rates are available.

References: Greenfield and Krishnamurti (1979).
Churchill and Houze (1984)

Project: WMONEX (1978)

Date(s): December, 1978

Location(s): South China Sea, Java Sea (Malaysia)

Participating Aircraft: NCAR (Lockheed "Electra")

Number of Flights: 3

Estimated Value of Flights for data on:

Supercooled LWC	?	Est. Max SLWC: ?
Snow	---	
Ice Particles	---	
Graupel	---	
Hail	---	
Rain	---	
Freezing Rain or Drizzle	---	

Cloud Physics Probes in Use:

JW LWC Meter	(1-45 μ m)	Yes
PMS FSSP	(3-45 ")	Yes (See note 1)
PMS 1D-C (200X)	(20-300 ")	Yes
PMS 2D-C	(25-800 ")	No
PMS 1D-P (200Y)	(0.3-4.5 mm)	X (See note 2)
PMS 2D-P	(0.2-6.4 mm)	No
Ice Particle Counter		No
Particle Replicator		No
Icing Rate Meter		No

Cloud Types Sampled:

Altitude Range for Data:

Data Custodian: NCAR/RAF, Boulder, Colorado

Remarks: 1 - FSSP inoperative for some flights

2 - PMS 200Y probe inoperative for all flights

Project: Univ. Chicago Lake-Effect Snow Project (1978)

Date(s): Nov. - Dec., 1978

Location(s): Lake Michigan vicinity

Participating Aircraft: NCAR (Beechcraft BE-80 "Queen Air")

Number of Flights: 11

Estimated Value of Flights for data on:

Supercooled LWC	OK (See note 1) Est. Max SLWC: ?
Snow	? (See notes 2, 3)
Ice Particles	? (See notes 2, 3)
Graupel	---
Hail	---
Rain	---
Freezing Rain or Drizzle	---

Cloud Physics Probes in Use:

JW LWC Meter (1-45 μ m)	Yes
PMS FSSP (3-45 ")	Yes (See notes 1, 2)
PMS 1D-C (200X) (20-300 ")	No
PMS 2D-C (25-800 ")	No
PMS 1D-P (200Y) (0.3-4.5 mm)	Yes (See notes 2, 3)
PMS 2D-P (0.2-6.4 mm)	No
Ice Particle Counter	No
Particle Replicator	No
Icing Rate Meter	?

Cloud Types Sampled: St, Sc

Altitude Range for Data: Below 15 k ft. (4.5 km)

Data Custodian: NCAR Research Aviation Facility, Boulder, Colorado
(Prof. R. R. Braham, Univ. Chicago, Principal Investigator)

- Remarks: 1 - FSSP data are faulty and therefore unavailable for LWC comparison.
- 2 - All PMS probe data are of questionable or limited value because of NCAR data system problems.
- 3 - No information available on particle shapes.

Project: USAF/AFGL Cirrus Studies (1978)

Date(s): Aug. - Sept., 1978

Location(s): OK, KS, NY

Participating Aircraft: MRI and Aeromet, Inc. (Gates Learjet 36)

Number of Flights: 10

Estimated Value of Flights for data on:

Supercooled LWC	---
Snow	---
Ice Particles	Good
Graupel	---
Hail	---
Rain	---
Freezing Rain or Drizzle	---

Cloud Physics Probes in Use:

JW LWC Meter (1-45 μ m)	Yes
PMS FSSP (3-45 ")	Yes
PMS 1D-C (200X) (20-300 ")	Yes
PMS 2D-C (25-800 ")	Yes
PMS 1D-P (200Y) (0.3-4.5 mm)	Yes
PMS 2D-P (0.2-6.4 mm)	Yes
Ice Particle Counter	---
Particle Replicator	---
Icing Rate Meter	---

Cloud Types Sampled: Cirrus and anvil cirrus

Altitude Range for Data: Above 20 k ft. (6 km) ASL

Data Custodian: ? Inquire at AFGL/LYC, Hanscom AFB, Massachusetts. (But funding may be required to prepare data for use outside of AFGL).

Remarks:

References: Cohen (1981),
Varley et al (1980),
Barnes et al (1982),
Cohen and Barnes (1980)

Project: TRIP* (1978)

*Thunderstorm Research International Project

Date(s): August, 1978

Location(s): Florida

Participating Aircraft: SDSM&T (North American, T-28)

Number of Flights: 4

Estimated Value of Flights for Data on:

Supercooled LWC	OK	Est. Max SLWC: 1 g/m ³
Snow	---	
Ice Particles	OK	
Graupel	OK	
Hail	OK	
Rain	?	
Freezing Rain or Drizzle	---	

Cloud Physics Probes in Use:

JW LWC Meter	(1-45 μm)	Yes
PMS FSSP	(2-30 ")	Yes
PMS 1D-C (200X)	(20-300 ")	No
PMS 2D-C	(25-800 ")	Yes
PMS 1D-P (200Y)	(0.3-4.5 mm)	No
PMS 2D-P	(0.2-6.4 mm)	No
Ice Particle Counter	(100 m)	No
Particle Replicator		Yes
Icing Rate Meter		No
Hail Spectrometer		No
"Cannon" Camera		Yes

Cloud Types Sampled: TCu and Cb

Altitude Range for Data: 17-23 k ft (5-7 km)

Data Custodian: SDSM&T, Rapid City, SD

Remarks:

Reference:

Project: NCAR/CSD Field Season (1978)

Date(s): July, 1978

Location(s): Northeast Colorado

Participating Aircraft: SDSM&T (North American, T-28)

Number of Flights: 9

Estimated Value of Flights for Data on:

Supercooled LWC	OK	Est. Max SLWC: 2 g/m ³
Snow	---	
Ice Particles	OK	
Graupel	OK	
Hail	---	
Rain	---	
Freezing Rain or Drizzle	---	

Cloud Physics Probes in Use:

JW LWC Meter	(1-45 μm)	Yes
PMS FSSP	(2-30 ")	Yes
PMS 1D-C (200X)	(20-300 ")	No
PMS 2D-C	(25-800 ")	Yes
PMS 1D-P (200Y)	(0.3-4.5 mm)	No
PMS 2D-P	(0.2-6.4 mm)	No
Ice Particle Counter	(100 m)	No
Particle Replicator		Yes
Icing Rate Meter		---
Hail Spectrometer		No
"Cannon" Camera		Yes

Cloud Types Sampled: TCu

Altitude Range for Data: 20 k ft (6 km) ASL

Data Custodian: SDSM&T & NCAR/CSD

Remarks:

Reference:

Project: NHRE* (1978)

*National Hail Research Experiment

Date(s): July, 1978

Location(s): Wyoming, Colorado

Participating Aircraft: Univ. Wyoming (Beechcraft BE-80 "Queen Air")

Number of Flights: 15

Estimated Value of Flights for Data on:

Supercooled LWC	Good	Est. Max SLWC: ?
Snow	---	
Ice Particles	Good	
Graupel	OK	
Hail	---	
Rain	?	
Freezing Rain or Drizzle	---	

Cloud Physics Probes in Use:

JW LWC Meter	(1-45 μ m)	Yes
PMS ASSP	(2-30 ")	Yes
PMS 1D-C (200X)	(20-300 ")	No
PMS 2D-C	(25-800 ")	Yes
PMS 1D-P (200Y)	(0.3-4.5 mm)	No
PMS 2D-P	(0.2-6.4 mm)	No
Ice Particle Counter		No
Particle Replicator (foil impactor)		Yes
Icing Rate Meter		No

Cloud Types Sampled: Cu, Cb

Altitude Range for Data: 8-23 k ft (2.5-7 km) ASL

Data Custodian: Univ. Wyoming, Laramie, Wyoming

Remarks:

Reference:

Project: NHRE (1978)

Date(s): June - Aug., 1978

Location(s): Wyoming, Colorado

Participating Aircraft: SDSM&T (North American T-28)

Number of Flights: 10

Estimated Value of Flights for Data on:

Supercooled LWC	OK	Est. Max SLWC: ?
Snow	?	
Ice Particles	Good	
Graupel	Good	
Hail	OK?	
Rain	---	
Freezing Rain or Drizzle	---	

Cloud Physics Probes in Use:

JW LWC Meter	(1-45 μ m)	Yes
PMS FSSP	(2-30 ")	Yes
PMS 1D-C (200X)	(20-300 ")	No
PMS 2D-C	(25-800 ")	Yes
PMS 1D-P (200Y)	(0.3-4.5 mm)	No
PMS 2D-P	(0.2-6.4 mm)	No
Ice Particle Counter		No
Particle Replicator		Yes
Icing Rate Meter		No
Hail Spectrometer		Yes

Cloud Types Sampled: Cu, Cb

Altitude Range for Data: ?

Data Custodian: SDSM&T, Rapid City, SD

Remarks:

Reference:

Project: NHRE (1978)

Date(s): June, July, 1978

Location(s): Wyoming, Colorado

Participating Aircraft: NCAR/NOAA (Schweizer 2-32 Sailplane)

Number of Flights: 11

Estimated Value of Flights for Data on:

Supercooled LWC	OK	Est. Max SLWC: ?
Snow	?	
Ice Particles	OK	
Graupel	OK	
Hail	---	
Rain	---	
Freezing Rain or Drizzle	---	

Cloud Physics Probes in Use:

JW LWC Meter	(1-45 μ m)	Yes
PMS FSSP	(2-30 ")	Yes
PMS 1D-C (200X)	(20-300 ")	No
PMS 2D-C	(25-800 ")	No
PMS 1D-P (200Y)	(0.3-4.5 mm)	No
PMS 2D-P	(0.2-6.4 mm)	No
Ice Particle Counter		No
Particle Replicator ("Cannon" Camera)		Yes
Icing Rate Meter		No

Cloud Types Sampled: Cu, Sc
Altitude Range for Data: 9-30 k ft (3-9 km) ASL
Data Custodian: NCAR/CSD, Boulder, Colorado

Remarks: Copies of archived data tapes may be difficult to obtain because of format incompatibilities between the original tapes and the new computer system installed at NCAR in the meantime.

Reference: "July 1978 Data Summaries", unnumbered report by NCAR/CSD.

Project: FACE*-II, (1978)

*Florida Area Cumulus Experiment

Date(s): June - Aug., 1978

Location(s): Florida

Participating Aircraft: Aero Systems, Inc. (North American Rockwell,
"Aero Commander")

Number of Flights: 33

Estimated Value of Flights for data on:

Supercooled LWC	Good (See note 1)
	Est. Max SLWC: 5 g/m ³
Snow	?
Ice Particles	Excellent (See note 2)
Graupel	Good
Hail	?
Rain	---
Freezing Rain or Drizzle	---

Cloud Physics Probes in Use:

JW LWC Meter	(1-45 μm)	Yes
PMS FSSP	(3-45 ")	Yes (See note 3)
PMS 1D-C (200X)	(20-300 ")	Yes (See note 4)
PMS 2D-C	(25-800 ")	No
PMS 1D-P (200Y)	(0.3-4.5 mm)	No
PMS 2D-P	(0.2-6.4 mm)	No
Ice Particle Counter		No
Particle Replicator		Yes
Icing Rate Meter		No

Cloud Types Sampled: Cu

Altitude Range for Data: -10°C level (15-21 k ft.), (4.5-6 km) ASL

Data Custodian: Inquire at NOAA/NHEML, Coral Gables, Florida.

Remarks: 1 - Lots of cloud penetrations, some with large SLWCs (from JW) up to 5 g/m³ but FSSP performance is disappointing.

2 - Jordan et al (1981) has excellent tables of ice Xtal concentrations and JW LWCs.

3 - FSSP was inoperative during first half of the field project.

4 - PMS 200X probe was inoperative during the first quarter of the project.

References: 1. Jordan et al (1981)

2. "1978 FACE Operational Summary and Data Inventory"

Project: FACE-2 (1978)

Date(s): August, 1978

Location(s): Florida

Participating Aircraft: NOAA (Lockheed WP-3D)

Number of Flights: 9

Estimated Value of Flights for data on:

Supercooled LWC	OK (See note 1)	Est. Max SLWC: ?
Snow	?	
Ice Particles	Good	
Graupel	Good	
Hail	?	
Rain	---	
Freezing Rain or Drizzle	---	

Cloud Physics Probes in Use:

JW LWC Meter	(1-45 μm)	Yes
PMS FSSP or ASSP	(3-45 ")	Yes (See note 2)
PMS 1D-C (200X)	(20-300 ")	No
PMS 2D-C	(25-800 ")	Yes
PMS 1D-P (200Y)	(0.3-4.5 mm)	No
PMS 2D-P	(0.2-6.4 mm)	Yes
Ice Particle Counter		Yes
Particle Replicator		Yes
Icing Rate Meter		No

Cloud Types Sampled: Cu

Altitude Range for Data: 17-23 k ft. (-16°C level), (5-7 km) ASL

Data Custodian: NOAA/ERL, Boulder, Colorado

(Principal Investigator: Dr. Roger Reinking)

Remarks: 1 - Some data are good, some are questionable.

2 - No strobes or probe activity rates are available.

Project: FACE-2 (1978)

Date(s): July-Aug., 1978

Location(s): Florida

Participating Aircraft: Univ. Wyoming (Beechcraft BE-200, "King Air")

Number of Flights: 11

Estimated Value of Flights for data on:

Supercooled LWC	Good	Est. Max SLWC: > 3 g/m ³
Snow	?	
Ice Particles	Good	
Graupel	Good	
Hail	?	
Rain	OK	
Freezing Rain or Drizzle	---	

Cloud Physics Probes in Use:

JW LWC Meter	(1-45 μm)	Yes
PMS FSSP	(3-45 ")	Yes
PMS 1D-C (200X)	(20-300 ")	Yes
PMS 2D-C	(25-800 ")	Yes
PMS 1D-P (200Y)	(0.3-4.5 mm)	Yes
PMS 2D-P	(0.2-6.4 mm)	Yes
Ice Particle Counter		No
Particle Replicator		Yes
Icing Rate Meter		No

Cloud Types Sampled: Cu, Cb

Altitude Range for Data: 10-20 k ft. (-4°C level), (3-6 km) ASL

Data Custodian: Univ. Wyoming, Laramie, Wyoming

Remarks:

Project: NAE/AES* Summer Cumulus Project (1978)

*Canadian National Aeronautical Establishment/Atmospheric Environment Service

Date(s): June - July, 1978

Location(s): Ontario (Thunder Bay), Canada

Participating Aircraft: NAE/AES (DeHavilland DHC-6 "Twin Otter")

Number of Flights: 9

Estimated Value of Flights for data on:

Supercooled LWC	Good	Est. Max SLWC: 3 g/m ³
Snow	?	
Ice Particles	Good	
Graupel	Good	
Hail	---	
Rain	?	
Freezing Rain or Drizzle	---	

Cloud Physics Probes in Use:

JW LWC Meter	(1-45 μ m)	Yes
PMS FSSP	(3-45 ")	Yes (See note 1)
PMS 1D-C (200X)	(20-300 ")	Yes
PMS 2D-C	(25-800 ")	Yes
PMS 1D-P (200Y)	(0.3-4.5 mm)	No
PMS 2D-P	(0.2-6.4 mm)	Yes
Ice Particle Counter		Yes
Particle Replicator		Yes
Icing Rate Meter		No

Cloud Types Sampled: Cu

Altitude Range for Data: 10-18 k ft. (3-5 km) ASL

Data Custodian: Canadian Atmospheric Environment Service, Downsview, Ontario

Remarks: 1 - Some instrument problems.

References: MacPherson (1979)
Isaac et al (1982)

Project: NAE/AES Summer Cumulus Project (1978)

Date(s): June - July, 1978

Location(s): Ontario (Thunder Bay), Canada

Participating Aircraft: NAE/AES (T-33)

Number of Flights: 9

Estimated Value of Flights for data on:

Supercooled LWC	OK (See note 1)	Est. Max SLWC: 3 g/m ³
Snow	---	
Ice Particles	---	
Graupel	---	
Hail	---	
Rain	---	
Freezing Rain or Drizzle	---	

Cloud Physics Probes in Use:

JW LWC Meter	(1-45 μ m)	Yes
PMS FSSP	(3-45 ")	No
PMS 1D-C (200X)	(20-300 ")	No
PMS 2D-C	(25-800 ")	No
PMS 1D-P (200Y)	(0.3-4.5 mm)	No
PMS 2D-P	(0.2-6.4 mm)	No
Ice Particle Counter		No
Particle Replicator		No
Icing Rate Meter		No

Cloud Types Sampled: Cu

Altitude Range for Data: 10-18 k ft. (3-5 km) ASL

Data Custodian: Canadian AES, Downsview, Ontario.

Remarks: 1 - No PMS ASSP or FSSP available for droplet sizes or for comparison of LWC with JW.

Reference: MacPherson (1979)

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Project: NAE/AES Summer Cumulus Project (1978)

Date(s): June - July, 1978

Location(s): Ontario (Thunder Bay), Canada

Participating Aircraft: NAE/AES (Beechcraft D-18)

Number of Flights: 9

Estimated Value of Flights for data on:

Supercooled LWC	---	Est. Max SLWC: ---
Snow	?	
Ice Particles	OK	(See note 1)
Graupel	OK	(See note 1)
Hail	---	
Rain	---	
Freezing Rain or Drizzle	---	

Cloud Physics Probes in Use:

JW LWC Meter	(1-45 μ m)	No
PMS FSSP or ASSP	(3-45 ")	No
PMS 1D-C (200X)	(20-300 ")	No
PMS 2D-C	(25-800 ")	No
PMS 1D-P (200Y)	(0.3-4.5 mm)	Yes (See note 1)
PMS 2D-P	(0.2-6.4 mm)	No
Ice Particle Counter		No
Particle Replicator		No
Icing Rate Meter		No

Cloud Types Sampled: Cu

Altitude Range for Data:

Data Custodian: Canadian AES, Downsview, Ontario

Remarks: 1 - No information available on particle shapes.

Reference: MacPherson (1979)

Project: PACE* (1978)

*Precipitation Augmentation for Crops Experiment

Date(s): June 1978

Location(s): Illinois

Participating Aircraft: NOAA (Lockheed P-3)

Number of Flights: 7

Estimated Value of Flights for Data on:

Supercooled LWC	Good	Est. Max SLWC: > 2 g/m ³
Snow	Fair	
Ice Particles	Good	
Graupel	Good	
Hail	?	
Rain	---	
Freezing Rain or Drizzle	---	

Cloud Physics Probes in Use:

JW LWC Meter	(1-45 μ m)	Yes
PMS FSSP	(2-30 ")	Yes
PMS 1D-C (200X)	(20-300 ")	No
PMS 2D-C	(25-800 ")	Yes
PMS 1D-P (200Y)	(0.3-4.5 mm)	No
PMS 2D-P	(0.2-6.4 mm)	Yes
Ice Particle Counter		Yes
Particle Replicator		No
Icing Rate Meter		No

Cloud Types Sampled: Cu, Cb, Ac

Altitude Range for Data: 10-20 k ft (3-6 km) ASL

Data Custodian: Illinois State Water Survey, Champaign, Illinois

Remarks:

Reference:

Project: HIPLEX* (1978)

*High Plains Cooperative Program

Date(s): May - July 1978

Location(s): Montana, Kansas

Participating Aircraft: Univ. Wyoming (Beechcraft, BE-200 "King Air")

Number of Flights: 29

Estimated Value of Flights for Data on:

Supercooled LWC	Good	Est. Max SLWC: ?
Snow	?	
Ice Particles	Good	
Graupel	Good	
Hail	?	
Rain	?	
Freezing Rain or Drizzle	---	

Cloud Physics Probes in Use:

JW LWC Meter	(1-45 μ m)	Yes
PMS FSSP or ASSP	(2-30 ")	Yes
PMS 1D-C (200X)	(20-300 ")	Yes
PMS 2D-C	(25-800 ")	Yes
PMS 1D-P (200Y)	(0.3-4.5 mm)	No
PMS 2D-P	(0.2-6.4 mm)	Yes
Ice Particle Counter		No
Particle Replicator		Yes
Icing Rate Meter		No

Cloud Types Sampled: TCu, Cu, Sc, Ac

Altitude Range for Data: Mid cloud, 0 to -15°C level

Data Custodian: Bureau of Reclamation, Denver, Colorado

Remarks:

Reference: "Project Skywater Data Inventory", 1978 HIPLEX Season

Project: HIPLEX* (1978)

Date(s): May - July 1978

Location(s): Kansas, Texas

Participating Aircraft: MRI (Piper "Navajo")

Number of Flights: 16 (See note 1)

Estimated Value of Flights for Data on:

Supercooled LWC	OK (See note 1)	Est. Max SLWC: 2 g/m ³
Snow	?	
Ice Particles	OK	
Graupel	OK	
Hail	OK	
Rain	---	
Freezing Rain or Drizzle	---	

Cloud Physics Probes in Use:

JW LWC Meter	(1-45 μ m)	Yes
PMS FSSP or ASSP	(2-30 ")	Yes
PMS 1D-C (200X)	(20-300 ")	Yes
PMS 2D-C	(25-800 ")	Yes
PMS 1D-P (200Y)	(0.3-4.5 mm)	Yes
PMS 2D-P	(0.2-6.4 mm)	No
Ice Particle Counter		Yes
Particle Replicator		Yes
Icing Rate Meter		No

Cloud Types Sampled: TCu, Cb, Cu

Altitude Range for Data: ?

Data Custodian: Bureau of Reclamation, Denver, Colorado

Remarks: 1 - Aircraft operated primarily near cloud base, so it is not known how many flight legs are above the freezing level.

Reference: Riggio and Alexander (1978)

Project: HIPLEX (1978)

Date(s): May - July 1978

Location(s): Kansas, Texas, Montana

Participating Aircraft: Colorado International Corp. (Learjet 23)

Number of Flights: 13

Estimated Value of Flights for Data on:

Supercooled LWC	OK (See note 1)	Est. Max SLWC: ?
Snow	---	
Ice Particles	Good	
Graupel	OK	
Hail	---	
Rain	---	
Freezing Rain or Drizzle	---	

Cloud Physics Probes in Use:

JW LWC Meter	(1-45 μ m)	Yes
PMS FSSP	(2-30 ")	No (See note 1)
PMS 1D-C (200X)	(20-300 ")	No
PMS 2D-C	(25-800 ")	Yes
PMS 1D-P (200Y)	(0.3-4.5 mm)	No
PMS 2D-P	(0.2-6.4 mm)	No
Ice Particle Counter		Yes
Particle Replicator		No
Icing Rate Meter		No

Cloud Types Sampled: TCu, Cu

Altitude Range for Data: -10°C level (if one existed)

Data Custodian: Bureau of Reclamation, Denver, Colorado

Remarks: 1 - No FSSP available for droplet sizes or LWC comparison.

Reference: Riggio and Alexander (1978)

Project: HIPLEX (1978)

Date(s): June - July 1978

Location(s): Texas

Participating Aircraft: Colo. River Mun. Water District (Piper "Astec")

Number of Flights: 10 (See note 1)

Estimated Value of Flights for Data on:

Supercooled LWC	---	Est. Max SLWC:
Snow	?	
Ice Particles	?	
Graupel	?	
Hail	?	
Rain	?	
Freezing Rain or Drizzle	---	

Cloud Physics Probes in Use:

JW LWC Meter	(1-45 μ m)	No
PMS FSSP	(2-30 ")	No
PMS 1D-C (200X)	(20-300 ")	No
PMS 2D-C	(25-800 ")	No
PMS 1D-P (200Y)	(0.3-4.5 mm)	Yes (See note 2)
PMS 2D-P	(0.2-6.4 mm)	No
Ice Particle Counter		No
Particle Replicator		No
Icing Rate Meter		No

Cloud Types Sampled: Cu

Altitude Range for Data: 15 k ft max

Data Custodian: Texas Department of Water Resources, Austin, Texas

Remarks: 1 - Aircraft operated as a cloud base seeder and sampler, so it is doubtful that any flights were above the freezing level.

2 - Minimal data except perhaps for PMS 1D-P data on rain?

Reference: Riggio and Alexander (1978)

Project: USAF/AFGL LSCS* (1978)

*Large Scale Cloud Systems

Date(s): March, 1978

Location(s): NM, AR, TX, OK, IL, PA, and Atlantic Ocean near Delaware

Participating Aircraft: USAF/AFGL (Lockheed MC-130E)

Number of Flights: 7

Estimated Value of Flights for data on:

Supercooled LWC	OK (See note 1)
	Est. Max SLWC: 0.5 g/m ³
Snow	Excellent
Ice Particles	Good
Graupel	?
Hail	---
Rain	Good
Freezing Rain or Drizzle	?

Cloud Physics Probes in Use:

JW LWC Meter (1-45 μ m)	Yes
PMS FSSP or ASSP (3-45 ")	Yes
PMS 1D-C (200X) (20-300 ")	Yes
PMS 2D-C (25-800 ")	Yes
PMS 1D-P (200Y) (0.3-4.5 mm)	Yes
PMS 2D-P (0.2-6.4 mm)	Yes
Ice Particle Counter	No
Particle Replicator	Yes
Icing Rate Meter	No

Cloud Types Sampled: Mostly wintertime wave cyclones and snowstorms in continental air. Also cirrus.

Altitude Range for Data:

Data Custodian: AFGL/LYC, Hanscom AFB, Massachusetts. (But will require funding to prepare data for use outside of AFGL).

Remarks: 1 - Clouds mostly glaciated, and therefore LWC is minimal.

References: Barnes et al (1982), Cohen (1981), Varley (1980)

Project: EAE*-1 (1978)

Date(s): Jan. - Feb., 1978

Location(s): Colorado (mountains)

Participating Aircraft: NCAR (Beechcraft BE-80 "Queen Air")

Number of Flights: 10

Estimated Value of Flights for data on:

Supercooled LWC	?	Est. Max SLWC: ?
Snow	?	
Ice Particles	?	
Graupel	?	
Hail	---	
Rain	?	
Freezing Rain or Drizzle	?	

Cloud Physics Probes in Use:

JW LWC Meter (1-45 μ m)	Yes
PMS FSSP (3-45 ")	?
PMS 1D-C (200X) (20-300 ")	No
PMS 2D-C (25-800 ")	?
PMS 1D-P (200Y) (0.3-4.5 mm)	No
PMS 2D-P (0.2-6.4 mm)	?
Ice Particle Counter	No
Particle Replicator	No
Icing Rate Meter	No

Cloud Types Sampled: Orographically assisted storm systems.

Altitude Range for Data: ?

Data Custodian: Colorado State University, Fort Collins, Colorado

Remarks:

Project: SCPP* (1977-78)

*Sierra Cooperative Pilot Project

Date(s): Dec. 1977 - March, 1978

Location(s): California (Windward Sierra Mountains)

Participating Aircraft: Univ. Wyoming (Beechcraft BE-200, "King Air")

Number of Flights: 27

Estimated Value of Flights for data on:

Supercooled LWC	Good (See note 1)
	Est. Max SLWC: 4 g/m ³
Snow	OK
Ice Particles	Good
Graupel	?
Hail	---
Rain	---
Freezing Rain or Drizzle	---

Cloud Physics Probes in Use:

JW LWC Meter	(1-45 μ m)	Yes
PMS FSSP	(3-45 ")	Yes (See note 1)
PMS 1D-C (200X)	(20-300 ")	Yes
PMS 2D-C	(25-800 ")	Yes
PMS 1D-P (200Y)	(0.3-4.5 mm)	No
PMS 2D-P	(0.2-6.4 mm)	Yes
Ice Particle Counter		?
Particle Replicator		Yes
Icing Rate Meter		No

Cloud Types Sampled: Cu, Sc, orographic
 Altitude Range for Data: 15 k ft. (4.5 km) ASL
 Data Custodian: Bureau of Reclamation, Denver, Colorado

Remarks: 1 - FSSP data are erroneous and unusable for this SCPP season

Reference: Project Skywater Data Inventory, 1977-78 SCPP Season

Project: Univ. Chicago Lake-Effect Snow Project (1977)

Date(s): Nov. - Dec., 1977

Location(s): Lake Michigan vicinity

Participating Aircraft: NCAR (Beechcraft BE-80 "Queen Air")

Number of Flights: 12

Estimated Value of Flights for data on:

Supercooled LWC	OK (See note 1) Est. Max SLWC: ?
Snow	? (See notes 2, 3)
Ice Particles	? (See notes 2, 3)
Graupel	---
Hail	---
Rain	---
Freezing Rain or Drizzle	---

Cloud Physics Probes in Use:

JW LWC Meter	(1-45 μ m)	Yes
PMS FSSP	(3-45 ")	Yes (See note 2)
PMS 1D-C (200X)	(20-300 ")	No
PMS 2D-C	(25-800 ")	No
PMS 1D-P (200Y)	(0.3-4.5 mm)	Yes (See notes 2, 3)
PMS 2D-P	(0.2-6.4 mm)	No
Ice Particle Counter		No
Particle Replicator		No
Icing Rate Meter		?

Cloud Types Sampled: St, Sc
 Altitude Range for Data: Below 15 k ft. (4.5 km) ASL
 Data Custodian: NCAR Research Aviation Facility, Boulder, Colorado
 (Principal Investigator: Prof. R. R. Braham, Univ. Chi.)

Remarks: 1 - FSSP data are faulty and therefore unavailable for LWC comparison

2 - All PMS probe data are of questionable or limited value because of data system problems.

3 - No information available on particle shapes.

Project: NOAA/NHRL Hurricane Flights (1977)

Date(s): Aug. - Oct., 1977

Location(s): Caribbean, Gulf of Mexico, tropical NW Atlantic, Pacific near Mexico

Participating Aircraft: NOAA/NHRL (Lockheed WP-3D)

Number of Flights: 5 (with cloud data above the 0°C level)
5 (with cloud data below the 0°C level)

Estimated Value of Flights for data on:

Supercooled LWC	Fair (See note 1) Est. Max SLWC: 2-3 g/m ³
Snow	?
Ice Particles	Good
Graupel	Good
Hail	---
Rain	Good
Freezing Rain or Drizzle	---

Cloud Physics Probes in Use:

JW LWC Meter	(1-45 μm)	Yes
PMS FSSP	(3-45 ")	Yes (See note 1)
PMS 1D-C (200X)	(20-300 ")	No
PMS 2D-C	(25-800 ")	Yes
PMS 1D-P (200Y)	(0.3-4.5 mm)	Yes
PMS 2D-P	(0.2-6.4 mm)	No
Ice Particle Counter		Yes
Particle Replicator (foil impactor)		Yes
Icing Rate Meter		No

Cloud Types Sampled: Tropical disturbance, tropical wave, and hurricanes.

Altitude Range for Data: 5 - 28 k ft. (1.5 - 8 km) ASL

Data Custodian: NOAA/NHRL, Coral Gables, Florida

Remarks: 1 - FSSP data have not been corrected for anything; FSSP reportedly gives low concentrations and 1/10 to 1/2 the JW-LWC. No strobes or probe activity rates are available. Also, hurricanes are reported to be well glaciated above the 0°C level, so not much SLWC except in convective bands where SLWC can reach 2-3 g/m³ sometimes.

Reference: Friedman et al (1982)

Project: NOAA/NHRL Hurricane Flights (1977)

Date(s): Aug. - Oct., 1977

Location(s): Caribbean, Gulf of Mexico, and tropical NW Atlantic

Participating Aircraft: NOAA/NHRL (Lockheed C-130B)

Number of Flights: 5 (with cloud data above the 0°C level)
2 (with cloud data below the 0°C level)

Estimated Value of Flights for data on:

Supercooled LWC	Fair (See note 1) Est. Max SLWC: 2-3 g/m ³
Snow	?
Ice Particles	OK
Graupel	Good
Hail	---
Rain	Good
Freezing Rain or Drizzle	---

Cloud Physics Probes in Use:

JW LWC Meter	(1-45 μm)	Yes
PMS FSSP or ASSP	(3-45 ")	X (See note 1)
PMS 1D-C (200X)	(20-300 ")	No
PMS 2D-C	(25-800 ")	No
PMS 1D-P (200Y)	(0.3-4.5 mm)	No
PMS 2D-P	(0.2-6.4 mm)	Yes
Ice Particle Counter		Yes
Particle Replicator (foil impactor)		Yes
Icing Rate Meter		No

Cloud Types Sampled: Tropical disturbance, tropical wave, and hurricanes

Altitude Range for Data: 10-24 k ft. (3-7 km) ASL

Data Custodian: NOAA/NHRL, Coral Gables, Florida

Remarks: 1 - FSSP available only for last flight, so information on droplet size and LWC comparisons are mostly unavailable.

Reference: Friedman et al (1982)

Project: Cloud Seedability Studies (1977)

Date(s): July, 1977

Location(s): Illinois, Georgia

Participating Aircraft: NOAA (Lockheed WP-3D)

Number of Flights: 2

Estimated Value of Flights for data on:

Supercooled LWC	Good	Est. Max SLWC: 3 g/m ³
Snow	---	
Ice Particles	---	
Graupel	Good	
Hail	---	
Rain	?	
Freezing Rain or Drizzle	---	

Cloud Physics Probes in Use:

JW LWC Meter	(1-45 μm)	Yes
PMS FSSP	(3-45 ")	No
PMS 1D-C (200X)	(20-300 ")	No
PMS 2D-C	(25-800 ")	No
PMS 1D-P (200Y)	(0.3-4.5 mm)	No
PMS 2D-P	(0.2-6.4 mm)	No
Ice Particle Counter		No
Particle Replicator		Yes
Icing Rate Meter		No

Cloud Types Sampled: TCu

Altitude Range for Data: 20 k ft. (6 km) ASL

Data Custodian: ? Inquire at NOAA/NHRL/AOML, Coral Gables, Florida 33146
(Victor Wiggert et al, Principal Investigators)

Remarks:

Reference: Wiggert et al (1982)

Project: NAE/AES* Summer Cumulus Project (1977)

*Canadian National Aeronautical Establishment/Atmospheric Environment Service

Date(s): June, July, 1977

Location(s): Ontario (Thunder Bay), Canada

Participating Aircraft: NAE/AES (DeHavilland DHC-6 "Twin Otter")

Number of Flights: 7

Estimated Value of Flights for data on:

Supercooled LWC	Good	Est. Max SLWC: 1 g/m ³
Snow	---	
Ice Particles	Good	
Graupel	?	
Hail	---	
Rain	?	
Freezing Rain or Drizzle	---	

Cloud Physics Probes in Use:

JW LWC Meter	(1-45 μm)	Yes
PMS FSSP	(3-45 ")	Yes (See note 1)
PMS 1D-C (200X)	(20-300 ")	Yes
PMS 2D-C	(25-800 ")	Yes
PMS 1D-P (200Y)	(0.3-4.5 mm)	No
PMS 2D-P	(0.2-6.4 mm)	No

Ice Particle Counter	Yes
Particle Replicator	Yes
Icing Rate Meter	No

Cloud Types Sampled: Cu

Altitude Range for Data: Up to 15 k ft. (4.5 km) ASL

Data Custodian: Canadian Atmospheric Environment Service, Downsview, Ontario, Canada

Remarks: 1 - Some instrument problems.

Reference: Isaac et al (1982)

Project: HIPLEX* (1977)

*High Plains Cooperative Program

Date(s): May - July, 1977

Location(s): Montana

Participating Aircraft: Colorado International Corp. (Learjet 23)

Number of Flights: 18

Estimated Value of Flights for data on:

Supercooled LWC	OK (See note 2)	Est. Max SLWC: ?
Snow	?	
Ice Particles	Fair (See note 3)	
Graupel	?	
Hail	---	
Rain	---	
Freezing Rain or Drizzle	---	

Cloud Physics Probes in Use:

JW LWC Meter	(1-45 μm)	Yes
PMS FSSP	(3-45 ")	No (See note 2)
PMS 1D-C (200X)	(20-300 ")	No
PMS 2D-C	(25-800 ")	No
PMS 1D-P (200Y)	(0.3-4.5 mm)	No
PMS 2D-P	(0.2-6.4 mm)	No
Ice Particle Counter		Yes
Particle Replicator		No
Icing Rate Meter		No

Cloud Types Sampled: Cu, Cb

Altitude Range for Data: 25 k ft. max. (7.5 km) ASL

Data Custodian: Bureau of Reclamation, Denver, Colorado

Remarks: 1 - Aircraft operated as a cloud seeding and ice particle survey aircraft near cloud top.

2 - No FSSP or ASSP available for droplet sizes or LWC comparisons.

3 - No information available on particle sizes or shapes.

Project: HIPLEX (1977)

Date(s): May - August, 1977

Location(s): Montana, Colorado, Kansas

Participating Aircraft: MRI (Piper, "Navajo")

Number of Flights: 48 (See note 2)

Estimated Value of Flights for data on:

Supercooled LWC	?	Est. Max SLWC: ?
Snow	---	
Ice Particles	?	
Graupel	---	
Hail	---	
Rain	---	
Freezing Rain or Drizzle	---	

Cloud Physics Probes in Use:

JW LWC Meter	(1-45 μm)	?
PMS ASSP	(3-45 ")	Yes
PMS 1D-C (200X)	(20-300 ")	?
PMS 2D-C	(25-800 ")	No
PMS 1D-P (200Y)	(0.3-4.5 mm)	No
PMS 2D-P	(0.2-6.4 mm)	No
Ice Particle Counter		No
Particle Replicator		No
Icing Rate Meter		No

Cloud Types Sampled: Cu

Altitude Range for Data: ?

Data Custodian: Bureau of Reclamation, Denver, Colorado

Remarks: 1 - Aircraft operated primarily as a subcloud and cloud base sampler, so may not have any supercooled cloud data.

2 - It is not known whether any of these flights were above cloud base or above the freezing level.

Project: HIPLEX (1977)

Date(s): May - Aug., 1977

Location(s): Montana, Colorado

Participating Aircraft: Univ. Wyoming (Beechcraft BE-80, "Queen Air")

Number of Flights: 47 (See note 1)

Estimated Value of Flights for data on:

Supercooled LWC	Good	Est. Max SLWC: ?
Snow	?	
Ice Particles	Good	
Graupel	Good	
Hail	---	
Rain	---	
Freezing Rain or Drizzle	---	

Cloud Physics Probes in Use:

JW LWC Meter (1-45 μ m)	Yes
PMS FSSP or ASSP (3-45 ")	Yes
PMS 1D-C (200X) (20-300 ")	?
PMS 2D-C (25-800 ")	?
PMS 1D-P (200Y) (0.3-4.5 mm)	?
PMS 2D-P (0.2-6.4 mm)	?
Ice Particle Counter	?
Particle Replicator	Yes
Icing Rate Meter	No

Cloud Types Sampled: Cu, Cb, TRW

Altitude Range for Data: ?

Data Custodian: Bureau of Reclamation, Denver, Colorado

Remarks: 1 - It is not known how many of these flights were above the freezing level.

Project: SCPP* (1976-77)

*Sierra Cooperative Pilot Project

Date(s): Jan. - March, 1977

Location(s): California (Windward Sierra Mountains)

Participating Aircraft: Univ. Washington, (Douglas B-23)

Number of Flights: 17

Estimated Value of Flights for data on:

Supercooled LWC	Good	Est. Max SLWC: ?
Snow	?	(See note 2)
Ice Particles	OK	(See note 2)
Graupel	?	(See note 2)
Hail	---	
Rain	---	
Freezing Rain or Drizzle	---	

Cloud Physics Probes in Use:

JW LWC Meter (1-45 μ m)	Yes ?
PMS ASSP (3-45 ")	Yes
PMS 1D-C (200X) (20-300 ")	?
PMS 2D-C (25-800 ")	No
PMS 1D-P (200Y) (0.3-4.5 mm)	?
PMS 2D-P (0.2-6.4 mm)	No
Ice Particle Counter	Yes
Particle Replicator	?
Icing Rate Meter	No

Cloud Types Sampled: Cu, Sc, orographic

Altitude Range for Data: 15 k ft. max (4.5 km) ASL

Data Custodian: Bureau of Reclamation, Denver, Colorado

Remarks: 1 - Not sure if PMS-ASSP data is easily accessible by this date. Flights from 1974 to 1976 (?) recorded only total droplet concentration?

2 - Not sure if information is available on particle sizes and shapes.

Project: NOAA/NHRL Hurricane Flights (1976)

Date(s): June - Sept., 1976

Location(s): Pacific Ocean near Mexico and 20°-35°N in the western North Atlantic.

Participating Aircraft: NOAA (Lockheed, WP-3D)

Number of Flights: 5 (with cloud data above the 0°C level)
5 (with cloud data below the 0°C level)

Estimated Value of Flights for data on:

Supercooled LWC	Fair (See note 1)	Est. Max SLWC: 2-3 g/m ³
Snow	?	
Ice Particles	Good	
Graupel	Good	
Hail	---	
Rain	Good	
Freezing Rain or Drizzle	---	

Cloud Physics Probes in Use:

JW LWC Meter	(1-45 μm)	Yes
PMS FSSP	(3-45 ")	Yes (See note 1)
PMS 1D-C (200X)	(20-300 ")	No
PMS 2D-C	(25-800 ")	Yes
PMS 1D-P (200Y)	(0.3-4.5 mm)	No
PMS 2D-P	(0.2-6.4 mm)	Yes
Ice Particle Counter		Yes
Particle Replicator		No
Icing Rate Meter		No

Cloud Types Sampled: Hurricane

Altitude Range for Data: 5-28 k ft. (1.5-8 km) ASL

Data Custodian: NOAA/NHRL, Coral Gables, Florida

Remarks: 1 - FSSP data have not been corrected for anything; FSSP reportedly gives low concentrations and 1/10 to 1/2 the JW-LWC. No strobes or probe activity rates are available. Also, hurricanes are reported to be well glaciated above the 0°C level, so not much SLWC except in convective bands where SLWC can reach 2-3 g/m³ sometimes.

Reference: Friedman et al (1982)

Project: NOAA/NHRL Hurricane Flights (1976)

Date(s): June - Sept., 1976

Location(s): 20°-35°N in NW Atlantic

Participating Aircraft: NOAA (Lockheed C-130B)

Number of Flights: 7 (with cloud data above the 0°C level)
4 (with cloud data below the 0°C level)

Estimated Value of Flights for data on:

Supercooled LWC	Fair (See note 1)	Est. Max SLWC: 2-3 g/m ³
Snow	?	
Ice Particles	Poor	
Graupel	OK	
Hail	---	
Rain	OK	
Freezing Rain or Drizzle	---	

Cloud Physics Probes in Use:

JW LWC Meter	(1-45 μm)	Yes
PMS FSSP or ASSP	(3-45 ")	No
PMS 1D-C (200X)	(20-300 ")	No
PMS 2D-C	(25-800 ")	No
PMS 1D-P (200Y)	(0.3-4.5 mm)	No
PMS 2D-P	(0.2-6.4 mm)	No
Ice Particle Counter	(>100 μm)	Yes
Particle Replicator (foil impactor)		Yes
Icing Rate Meter		No

Cloud Types Sampled: Hurricanes

Altitude Range for Data: 5-20 k ft. (1.5-6 km) ASL

Data Custodian: NOAA/NHRL, Coral Gables, Florida

Remarks: 1 - No ASSP available for droplet sizes or LWC comparisons.

Reference: Friedman et al (1982)

Project: FACE* (1976)

*Florida Area Cumulus Experiment

Data(s): Jun. - Aug., 1976

Location(s): Florida

Participating Aircraft: NOAA (Piper "Navajo")

Number of Flights: 19

Estimated Value of Flights for Data on:

Supercooled LWC	OK (See note 1)	Est. Max SLWC: 3 g/m ³
Snow	—	
Ice Particles	Good	
Graupel	Good	
Hail	—	
Rain	?	
Freezing Rain or Drizzle	—	

Cloud Physics Probes in Use:

JW LWC Meter	(1-45 μ m)	Yes (See note 1)
PMS FSSP	(2-30 ")	No
PMS 1D-C (200X)	(20-300 ")	No
PMS 2D-C	(25-800 ")	No
PMS 1D-P (200Y)	(0.3-4.5 mm)	No
PMS 2D-P	(0.2-6.4 mm)	No
Ice Particle Counter	(100 μ)	No
Particle Replicator (Formvar)		Yes
Icing Rate Meter		No

Cloud Types Sampled: Cu, TCu

Altitude Range for Data: -7°C to -12°C levels

Data Custodian: NOAA/NHEML, Coral Gables, Florida

Remarks: 1 - No ASSP or FSSP available for LWC comparison.

Reference: Sax et al (1979)

Project: NHRE* (1976)

*National Hail Research Experiment

Date(s): June, July, 1976

Location(s): Northeastern Colorado

Participating Aircraft: Univ. Wyoming (Beechcraft BE-80 "Queen Air")

Number of Flights: 22

Estimated Value of Flights for data on:

Supercooled LWC	Good (See note 1)	Est. Max SLWC: 1.5 g/m ³
Snow	---	
Ice Particles	Good	
Graupel	Good	
Hail	No	
Rain	Some	
Freezing Rain or Drizzle	---	

Cloud Physics Probes in Use:

JW LWC Meter	(1-45 μ m)	Yes (See note 1)
PMS ASSP	(3-45 ")	Yes (See note 2)
PMS 1D-C (200X)	(20-300 ")	No
PMS 2D-C	(25-800 ")	Yes
PMS 1D-P (200Y)	(0.3-4.5 mm)	No
PMS 2D-P	(0.2-6.4 mm)	No
Ice Particle Counter		No
Particle Replicator		Yes
Icing Rate Meter		No

Cloud Types Sampled: Cb, Cu cong.
 Altitude Range for Data: Up to 20 k ft. (6 km) ASL
 Data Custodian: Univ. Wyoming, Laramie, Wyoming

Remarks: 1 - There were problems with the JW during June.

2 - ASSP saturated at droplet concentrations nearing 300 to 500 cm⁻³

Reference: Knight and Squires (1982), Breed (1978)

Project: NHRE (1976)

Date(s): June, July, 1976

Location(s): North eastern Colorado

Participating Aircraft: NCAR/NOAA (Schweizer 2-32 Sailplane)

Number of Flights: 10

Estimated Value of Flights for data on:

Supercooled LWC	Good	Est. Max SLWC: 3 g/m ³
Snow	Some (See note 1)	
Ice Particles	Some (See note 1)	
Graupel	Some (See note 1)	
Hail	---	
Rain	?	
Freezing Rain or Drizzle	---	

Cloud Physics Probes in Use:

JW LWC Meter	(1-45 μ m)	Yes
PMS FSSP	(3-45 ")	Yes (See note 2)
PMS 1D-C (200X)	(20-300 ")	No
PMS 2D-C	(25-800 ")	No
PMS 1D-P (200Y)	(0.3-4.5 mm)	No
PMS 2D-P	(0.2-6.4 mm)	No
Ice Particle Counter		No
Particle Replicator		Yes
Icing Rate Meter		No

Cloud Types Sampled: Cu congestus, TCu
 Altitude Range for Data: 16-32 k ft. (5-10 km) ASL
 Data Custodian: NCAR Convective Storms Division, Boulder, Colorado

Remarks: 1 - Measurements are from the "Cannon" camera only.

2 - FSSP data usually valid only for 5 to 10 min. after enter cloud, because of icing problems.

Reference: Knight and Squires (1982), Breed (1978)

Project: NHRE (1976)

Date(s): June - July, 1976

Location(s): Northeastern Colorado

Participating Aircraft: SDSM&T (T-28)

Number of Flights: 9

Estimated Value of Flights for data on:

Supercooled LWC	Good (See notes 1 and 2)
	Est. Max SLWC: 2.5 g/m ³
Snow	---
Ice Particles	OK
Graupel	OK
Hail	Good
Rain	?
Freezing Rain or Drizzle	---

Cloud Physics Probes in Use:

JW LWC Meter	(1-45 μ m)	Yes
PMS FSSP	(3-45 ")	Yes (See note 2)
PMS 1D-C (200X)	(20-300 ")	No
PMS 2D-C	(25-800 ")	Yes
PMS 1D-P (200Y)	(0.3-4.5 mm)	No
PMS 2D-P	(0.2-6.4 mm)	No
Ice Particle Counter		No
Particle Replicator (foil impactor)		Yes
Icing Rate Meter		No
Hail Spectrometer		Yes
"Cannon" Camera		Yes

Cloud Types Sampled: Cb

Altitude Range for Data: 20 k ft. (6 km) ASL

Data Custodian: So. Dakota School of Mines and Technology, (SDSM&T), Rapid City, South Dakota; and NCAR/CSD.

Remarks: 1 - Some uncertainty about the accuracy of the JW.

2 - FSSP saturated at droplet concentrations nearing 200 cm⁻³

Reference: Knight and Squires (1982), Breed (1978)

Project: NAE/AES* Summer Cumulus Project (1976)

*Canadian National Aeronautical Establishment/Atmospheric Environment Service

Date(s): June-July, 1976

Location(s): North West Territories (Yellowknife), Canada

Participating Aircraft: NAE/AES (DeHavilland DHC-6 "Twin Otter")

Number of Flights: 8

Estimated Value of Flights for data on:

Supercooled LWC	Good	Est. Max SLWC: 2.0 g/m ³
Snow	?	
Ice Particles	OK	(See note 1)
Graupel	?	
Hail	---	
Rain	?	
Freezing Rain or Drizzle	---	

Cloud Physics Probes in Use:

JW LWC Meter	(1-45 μ m)	Yes
PMS FSSP	(3-45 ")	Yes (See note 2)
PMS 1D-C (200X)	(20-300 ")	Yes (See note 1)
PMS 2D-C	(25-800 ")	No
PMS 1D-P (200Y)	(0.3-4.5 mm)	Yes (See note 1)
PMS 2D-P	(0.2-6.4 mm)	No
Ice Particle Counter		Yes
Particle Replicator		Yes
Icing Rate Meter		No

Cloud Types Sampled: Cu

Altitude Range for Data: 10-14 k ft. (3-45 km) ASL

Data Custodian: Canadian Atmospheric Environment Service, Downsview, Ontario, Canada.

Remarks: 1 - No information available on particle shape.

2 - Some instrument problems.

Reference: Isaac, et al (1982)

Project: HIPLEX* (1976)

*High Plains Cooperative Program

Date(s): June - July, 1976

Location(s): Montana

Participating Aircraft: Univ. Washington, (Douglas B-23)

Number of Flights: 19

Estimated Value of Flights for data on:

Supercooled LWC	Good	Est. Max SLWC: 4 g/m ³
Snow	?	
Ice Particles	Good	
Graupel	?	
Hail	---	
Rain	OK?	
Freezing Rain or Drizzle	---	

Cloud Physics Probes in Use:

JW LWC Meter	{ 1-45 μ m }	Yes
PMS ASSP	{ 3-45 " }	Yes
PMS 1D-C (200X)	(20-300 ")	Yes
PMS 2D-C	(25-800 ")	No
PMS 1D-P (200Y)	(0.3-4.5 mm)	Yes
PMS 2D-P	(0.2-6.4 mm)	No
Ice Particle Counter		Yes
Particle Replicator		Yes
Icing Rate Meter		No

Cloud Types Sampled: Sc, Ac, Cu, Cb

Altitude Range for Data: 15 k ft. (4.5 km) ASL

Data Custodian: Bureau of Reclamation, Denver, Colorado

Remarks: 1 - Not clear if dropsize data is available other than total concentration as in years 1974-75.

References: "1976 HIPLEX Data Inventory"; Hobbs et al (1978)

Project: HIPLEX (1976)

Date(s): May - July, 1976

Location(s): Montana

Participating Aircraft: MRI (Piper, "Navajo")

Number of Flights: 30

Estimated Value of Flights for data on:

Supercooled LWC	?	Est. Max SLWC: ?
Snow	?	
Ice Particles	OK	
Graupel	?	
Hail	---	
Rain	?	
Freezing Rain or Drizzle	---	

Cloud Physics Probes in Use:

JW LWC Meter	{ 1-45 μ m }	?
PMS ASSP	{ 3-45 " }	Yes
PMS 1D-C (200X)	(20-300 ")	Yes
PMS 2D-C	(25-800 ")	No
PMS 1D-P (200Y)	(0.3-4.5 mm)	Yes
PMS 2D-P	(0.2-6.4 mm)	No
Ice Particle Counter		No
Particle Replicator		Yes
Icing Rate Meter		No

Cloud Types Sampled: Cu, TCu

Altitude Range for Data: 10 k ft. (3 km) ASL

Data Custodian: Bureau of Reclamation, Denver, Colorado

Remarks: Aircraft operated mainly as a subcloud or cloud base sampler, especially for precipitation.

Project: HIPLEX (1976)

Date(s): Apr. - July, 1976

Location(s): Montana

Participating Aircraft: Convergence Systems, Inc., (No. Amer. Rockwell,
"Aero Commander")

Number of Flights: 30

Estimated Value of Flights for data on:

Supercooled LWC	Good	Est. Max SLMC: ?
Snow	?	
Ice Particles	Good	
Graupel	Good	
Hail	---	
Rain	---	
Freezing Rain or Drizzle	---	

Cloud Physics Probes in Use:

JW LWC Meter	(1-45 μm)	Yes
PMS FSSP or ASSP	(3-45 ")	Yes
PMS 1D-C (200X)	(20-300 ")	Yes
PMS 2D-C	(25-800 ")	No
PMS 1D-P (200Y)	(0.3-4.5 mm)	Yes
PMS 2D-P	(0.2-6.4 mm)	No
Ice Particle Counter		Yes
Particle Replicator		Yes
Icing Rate Meter		No

Cloud Types Sampled: Cu, Cb, Sc

Altitude Range for Data: Above freezing level

Data Custodian: Bureau of Reclamation, Denver, Colorado

Remarks: 1 - Aircraft operated mainly at the "precipitation formation level".

Project: USAF/AFGL Weather Erosion Studies (1976)

Date(s): Jan. - March, 1976

Location(s): Eastern United States and nearby Atlantic Ocean

Participating Aircraft: USAF (Lockheed C-130)

Number of Flights: 2

Estimated Value of Flights for data on:

Supercooled LWC	OK (See note 1) Est. Max SLWC: ?
Snow	OK
Ice Particles	OK
Graupel	?
Hail	?
Rain	?
Freezing Rain or Drizzle	?

Cloud Physics Probes in Use:

JW LWC Meter (1-45 μm)	Yes (See note 1)
PMS FSSP or ASSP (3-45 ")	Yes
PMS 1D-C (200X) (20-300 ")	Yes
PMS 2D-C (25-800 ")	Yes
PMS 1D-P (200Y) (0.3-4.5 mm)	Yes
PMS 2D-P (0.2-6.4 mm)	Yes
Ice Particle Counter	No
Particle Replicator	Yes
Icing Rate Meter	No

Cloud Types Sampled: Ci, Cb

Altitude Range for Data: Up to 10 km ASL

Data Custodian: AFGL/LYC, Hanscom AFB, Massachusetts. (But funding will be required to prepare data for use outside AFGL).

Remarks: 1 - Data from the hydrometeor probes (including the ASSP?) are frequently of limited value due to malfunctions or difficulties in performing analyses.

Reference: Conover and Bunting (1977)

Project: USAF/AFGL Weather Erosion Studies (1976)

Date(s): Apr. - Oct., 1976

Location(s): Kwajalein Island (Pacific Ocean), and Eastern United States

Participating Aircraft: Aeromet, Inc. and MRI, (Gates Learjet 36)

Number of Flights: 6

Estimated Value of Flights for data on:

Supercooled LWC	Good	Est. Max SLWC: ?
Snow	Good	
Ice Particles	Good	
Graupel	?	
Hail	?	
Rain	?	
Freezing Rain or Drizzle	?	

Cloud Physics Probes in Use:

JW LWC Meter (1-45 μm)	Yes
PMS FSSP or ASSP (3-45 ")	Yes
PMS 1D-C (200X) (20-300 ")	Yes
PMS 2D-C (25-800 ")	Yes
PMS 1D-P (200Y) (0.3-4.5 mm)	Yes
PMS 2D-P (0.2-6.4 mm)	Yes
Ice Particle Counter	No
Particle Replicator	No
Icing Rate Meter	No

Cloud Types Sampled: Cb

Altitude Range for Data: Up to 13 km

Data Custodian: AFGL/LYC, Hanscom AFB, Massachusetts. (But funding will be required to prepare data for use outside of AFGL).

Remarks:

Reference: Conover and Bunting (1977)

Project: HIPLEX* (1975)

*High Plains Cooperative Program

Date(s): August, 1975

Location(s): Montana

Participating Aircraft: Convergence Systems, Inc. (No. Amer. Rockwell,
"Aero Commander")

Number of Flights: 4

Estimated Value of Flights for data on:

Supercooled LWC	Good	Est. Max SLWC: ?
Snow	?	(See note 1)
Ice Particles	OK	(See note 1)
Graupel	OK	(See note 1)
Hail	---	
Rain	---	
Freezing Rain or Drizzle	---	

Cloud Physics Probes in Use:

JW LWC Meter	(1-45 μ m)	Yes
PMS ASSP	(3-45 ")	Yes
PMS 1D-C (200X)	(20-300 ")	Yes
PMS 2D-C	(25-800 ")	No
PMS 1D-P (200Y)	(0.3-4.5 mm)	Yes
PMS 2D-P	(0.2-6.4 mm)	No
Ice Particle Counter		Yes
Particle Replicator		No
Icing Rate Meter		No

Cloud Types Sampled: Cu, Cb

Altitude Range for Data: 14-18 k ft. (4-5.5 km) ASL

Data Custodian: Bureau of Reclamation, Denver, Colorado

Remarks: 1 - No information available on particle shapes.

Reference: "1975 HIPLEX Data Inventory"

Project: HIPLEX (1975)

Date(s): June - August, 1975

Location(s): Montana

Participating Aircraft: Univ. Washington (Douglas B-23)

Number of Flights: 3

Estimated Value of Flights for data on:

Supercooled LWC	?	(See note 2)	Est. Max SLWC: ?
Snow	?		
Ice Particles	?		
Graupel	?		
Hail	---		
Rain	---		
Freezing Rain or Drizzle	---		

Cloud Physics Probes in Use:

JW LWC Meter	(1-45 μ m)	Yes
PMS ASSP	(3-45 ")	Yes
PMS 1D-C (200X)	(20-300 ")	No
PMS 2D-C	(25-800 ")	No
PMS 1D-P (200Y)	(0.3-4.5 mm)	No
PMS 2D-P	(0.2-6.4 mm)	No
Ice Particle Counter		Yes
Particle Replicator		Yes
Icing Rate Meter		No

Cloud Types Sampled: Cu

Altitude Range for Data:

Data Custodian: Bureau of Reclamation, Denver, Colorado

Remarks: 1 - During 1975 and the first half of 1976, HIPLEX, the B-23 craft, was used almost exclusively for aerosol sampling.

2 - It is not known how many of these flights were above the freezing level.

Reference: Hobbs et al (1978)

Project: HIPLEX (1975)

Date(s): July - Sept., 1975

Location(s): Montana

Participating Aircraft: MRI (Piper, Navajo)

Number of Flights: 4 (See note 1)

Estimated Value of Flights for data on:

Supercooled LWC	Poor (See note 2) Est. Max SLWC: ?
Snow	---
Ice Particles	?
Graupel	?
Hail	---
Rain	?
Freezing Rain or Drizzle	---

Cloud Physics Probes in Use:

JW LWC Meter	(1-45 μm)	No (See note 2)
PMS ASSP	(3-45 ")	Yes
PMS 1D-C (200X)	(20-300 ")	?
PMS 2D-C	(25-800 ")	No
PMS 1D-P (200Y)	(0.3-4.5 mm)	?
PMS 2D-P	(0.2-6.4 mm)	No
Ice Particle Counter		?
Particle Replicator		?
Icing Rate Meter		No

Cloud Types Sampled: Cu, Cb?

Altitude Range for Data:

Data Custodian: Bureau of Reclamation, Denver, Colorado

Remarks: 1 - Aircraft operated primarily as a cloud base and subcloud sampler. Four flights were above the freezing level but only 500 ft. (.15 km) above cloud base. About nine other flights were 1-2 k ft. above cloud base but not above the freezing level.

2 - Apparently no JW LWC meter was available.

Project: FACE* (1975)

*Florida Area Cumulus Experiment

Date(s): July, 1975

Location(s): Florida

Participating Aircraft: NOAA (Douglas DC-6)

Number of Flights: 12

Estimated Value of Flights for Data on:

Supercooled LWC	OK (See note 1)	Est. Max SLWC: 2.5 g/m ³
Snow	---	
Ice Particles	Good	
Graupel	Good	
Hail	---	
Rain	?	
Freezing Rain or Drizzle	---	

Cloud Physics Probes in Use:

JW LWC Meter	(1-45 μm)	Yes (See note 1)
PMS FSSP	(2-30 ")	No
PMS 1D-C (200X)	(20-300 ")	No
PMS 2D-C	(25-800 ")	? (See note 2)
PMS 1D-P (200Y)	(0.3-4.5 mm)	No
PMS 2D-P	(0.2-6.4 mm)	? (See note 2)
Ice Particle Counter	(>100 μm)	Yes
Particle Replicator (foil and Formvar)		Yes
Icing Rate Meter		No

Cloud Types Sampled: Cu, TCu

Altitude Range for Data: -4°C to -10°C levels

Data Custodian: NOAA/NREML, Coral Gables, Florida

Remarks: 1 - No ASSP or FSSP available for LWC comparison.

2 - Uncertain which PMS 2D probe was used, but probe was not available for all flights.

Reference: 1 - Woodley and Sax (1976)

2 - Hallett et al (1978)

Project: NHRE* (1975)

*National Hail Research Experiment

Date(s): July, 1975

Location(s): Northeastern Colorado

Participating Aircraft: SDSM&T (North American T-28)

Number of Flights: 8

Estimated Value of Flights for data on:

Supercooled LWC	OK (See note 1)	Est. Max SLWC: 2.8 g/m ³
Snow	---	
Ice Particles	OK	
Graupel	OK	
Hail	Good	
Rain	?	
Freezing Rain or Drizzle	---	

Cloud Physics Probes in Use:

JW LWC Meter	(1-45 μ m)	Yes (See note 1)
PMS FSSP	(3-45 ")	Yes (See note 1)
PMS 1D-C (200X)	(20-300 ")	No
PMS 2D-C	(25-800 ")	Yes
PMS 1D-P (200Y)	(0.3-4.5 mm)	No
PMS 2D-P	(0.2-6.4 mm)	No
Ice Particle Counter		No
Particle Replicator		Yes
Icing Rate Meter		No
Hail Spectrometer		Yes

Cloud Types Sampled: Cb

Altitude Range for Data: 20 k ft. (6 km) ASL

Data Custodian: So. Dakota School of Mines and Technology (SDSM&T), Rapid City, South Dakota; and NCAR/CSD.

Remarks: 1 - Some uncertainty about the accuracy of the JW and the FSSP.

Reference: Knight and Squires (1982)

Project: AIDJEX* (1975)

*Arctic Ice Dynamic's Joint Experiment

Date(s): July, 1975

Location(s): Beaufort Sea

Participating Aircraft: NCAR (Lockheed, "Electra")

Number of Flights: 4

Estimated Value of Flights for data on:

Supercooled LWC	OK	Est. Max SLWC: 0.5 g/m ³
Snow	---	
Ice Particles	---	
Graupel	---	
Hail	---	
Rain	---	
Freezing Rain or Drizzle	---	

Cloud Physics Probes in Use:

JW LWC Meter	(1-45 μ m)	Yes
PMS FSSP or ASSP	(3-45 ")	No
PMS 1D-C (200X)	(20-300 ")	No
PMS 2D-C	(25-800 ")	No
PMS 1D-P (200Y)	(0.3-4.5 mm)	No
PMS 2D-P	(0.2-6.4 mm)	No
Ice Particle Counter		No
Particle Replicator		No
Icing Rate Meter		No

Cloud Types Sampled: Stratus

Altitude Range for Data: 0-10 k ft. (0-3 km) ASL

Data Custodian: NCAR Research Aviation Facility, Boulder, Colorado

Remarks: 1 - May be some temperature sensor errors due to probe icing. Some JW problems.

Reference: Herman (1977)

Project: NAE/AES* Summer Cumulus Project (1975)

*Canadian National Aeronautical Establishment/Atmospheric Environment Service

Date(s): July, 1975

Location(s): North West Territories (Yellowknife), Canada

Participating Aircraft: NAE/AES (DeHavilland DHC-6 "Twin Otter")

Number of Flights: 4

Estimated Value of Flights for data on:

Supercooled LWC	OK	Est. Max SLWC: 0.5 g/m ³
Snow	?	
Ice Particles	OK	(See note 1)
Graupel	?	
Hail	---	
Rain	?	
Freezing Rain or Drizzle	---	

Cloud Physics Probes in Use:

JW LWC Meter	(1-45 μ m)	Yes
PMS FSSP	(3-45 ")	Yes (See note 2)
PMS 1D-C (200X)	(20-300 ")	Yes (See notes 1, 2)
PMS 2D-C	(25-800 ")	No
PMS 1D-P (200Y)	(0.3-4.5 mm)	Yes (See notes 1, 2)
PMS 2D-P	(0.2-6.4 mm)	No
Ice Particle Counter		Yes
Particle Replicator		Yes
Icing Rate Meter		No

Cloud Types Sampled: Cu

Altitude Range for Data: Up to 11 k ft. (3.5 km) ASL

Data Custodian: Canadian Atmospheric Environment Service, Downsview, Ontario, Canada

Remarks: 1 - No information available on particle shape.

2 - Some instrumentation problems.

Reference: Isaac et al (1982)

Project: AMTEX* (1975)

*Air Mass Transformation Experiment

Date(s): 23, 24 Feb., 1975

Location(s): East China Sea

Participating Aircraft: ? (Piper Aztec)

Number of Flights: 1

Estimated Value of Flights for data on:

Supercooled LWC	?	(See notes 1, 2)
	Est. Max SLWC:	11 g/m ³ !?
Snow	---	
Ice Particles	---	
Graupel	---	
Hail	---	
Rain	---	
Freezing Rain or Drizzle	---	

Cloud Physics Probes in Use:

JW LWC Meter	(1-45 μm)	No
PMS FSSP or ASSP	(3-45 ")	No
PMS 1D-C (200X)	(20-300 ")	No
PMS 2D-C	(25-800 ")	No
PMS 1D-P (200Y)	(0.3-4.5 mm)	No
PMS 2D-P	(0.2-6.4 mm)	No
Ice Particle Counter		No
Particle Replicator		Yes (See note 1)
Icing Rate Meter		No

Cloud Types Sampled: Cu, Sc and streets following cold air outbreak over ocean.

Altitude Range for Data: 5-6 k ft. (1.5-2 km) ASL

Data Custodian: ?

Remarks: 1 - Cloud droplet spectra obtained with special MgO-coated spiral strip inside a cylindrical probe. LWC computed from droplet spectra only, and no independent LWC sensor.

2 - Data obtained near cloud tops whose temperatures ranged from only about -1.5°C to -3.5°C on Feb. 23 when had the largest LWCs. On Feb. 24 cloud top temps. were 1 to 2°C and therefore warmer than freezing, and LWCs were less than 0.3 g/m³.

Reference: "Scientific Results of the Air Mass Transformation Experiment (AMTEX) (1981)

Project: AMTEX (1975)

Date(s): Feb., 1975

Location(s): East China Sea

Participating Aircraft: NCAR (Lockheed "Electra")

Number of Flights: 9 (See note 1)

Estimated Value of Flights for data on:

Supercooled LWC	?	Est. Max SLWC: ?
Snow	?	
Ice Particles	?	
Graupel	---	
Hail	---	
Rain	---	
Freezing Rain or Drizzle	---	

Cloud Physics Probes in Use:

JW LWC Meter	(1-45 μm)	?
PMS FSSP or ASSP	(3-45 ")	?
PMS 1D-C (200X)	(20-300 ")	
PMS 2D-C	(25-800 ")	
PMS 1D-P (200Y)	(0.3-4.5 mm)	
PMS 2D-P	(0.2-6.4 mm)	
Ice Particle Counter		
Particle Replicator		
Icing Rate Meter		

Cloud Types Sampled: Sc

Altitude Range for Data:

Data Custodian: NCAR Research Aviation Facility, Boulder, Colorado.

Remarks: 1 - Most flight legs were at low altitude and below the freezing level.

Reference: Mitsuta and Tsukamoto (1975)

A-94

Project: USAF/AFGL Weather Erosion Studies (1975)

Date(s): Jan. - June, 1975

Location(s): Eastern United States and nearby Atlantic Ocean

Participating Aircraft: USAF (Lockheed C-130)

Number of Flights: 27

Estimated Value of Flights for data on:

Supercooled LWC	OK (See note 1) Est. Max SLWC: ?
Snow	OK
Ice Particles	OK
Graupel	?
Hail	?
Rain	?
Freezing Rain or Drizzle	?

Cloud Physics Probes in Use:

JW LWC Meter	(1-45 μ m)	Yes (See note 1)
PMS FSSP	(3-45 ")	Yes
PMS 1D-C (200X)	(20-300 ")	Yes
PMS 2D-C	(25-800 ")	Yes
PMS 1D-P (200Y)	(0.3-4.5 mm)	Yes
PMS 2D-P	(0.2-6.4 mm)	Yes
Ice Particle Counter		No
Particle Replicator		Yes
Icing Rate Meter		No

Cloud Types Sampled: Wide variety

Altitude Range for Data: Up to 10 km

Data Custodian: AFGL/LYC, Hanscom AFB, Massachusetts. (But funding will be required to prepare data for use outside AFGL).

Remarks: 1 - Data from the hydrometeor probes (including the ASSP?) are frequently of limited value due to malfunctions or difficulties in performing analyses.

Reference: Conover and Bunting (1977)

Project: Colorado River Basin Pilot Project (1974-75)

Date(s): Dec. 1974 - March, 1975

Location(s): San Juan Mountains, Colorado

Participating Aircraft: U. Wyoming (Beechcraft B-80 "Queen Air")

Number of Flights: 8

Estimated Value of Flights for data on:

Supercooled LWC	OK (See note 1)	Est. Max SLWC: 1.5 g/m ³
Snow	OK	
Ice Particles	Good	
Graupel	OK	
Hail	---	
Rain	---	
Freezing Rain or Drizzle	---	

Cloud Physics Probes in Use:

JW LWC Meter	(1-45 μ m)	Yes (See note 1)
PMS ASSP	(3-45 ")	Yes (See note 1)
PMS 1D-C (200X)	(20-300 ")	No
PMS 2D-C	(25-800 ")	Yes
PMS 1D-P (200Y)	(0.3-4.5 mm)	No
PMS 2D-P	(0.2-6.4 mm)	No
Ice Particle Counter		Yes
Particle Replicator		Yes
Icing Rate Meter		No

Cloud Types Sampled: Orographic Sc, Ns

Altitude Range for Data:

Data Custodian: Univ. Wyoming, Laramie, Wyoming

Remarks: 1 - Some instrument problems.

Reference: Cooper and Saunders (1980)

Project: USAF/AFGL Weather Erosion Studies (1974)

Date(s): Jan. - June, 1974

Location(s): Eastern United States and nearby Atlantic Ocean

Participating Aircraft: USAF (Lockheed C-130)

Number of Flights: 10

Estimated Value of Flights for data on:

Supercooled LWC	OK (See note 1)	Est. Max SLWC: ?
Snow	OK	
Ice Particles	OK	
Graupel	?	
Hail	?	
Rain	?	
Freezing Rain or Drizzle	?	

Cloud Physics Probes in Use:

JW LWC Meter	(1-45 μ m)	Yes (See note 1)
PMS ASSP	(3-45 ")	Yes
PMS 1D-C (200X)	(20-300 ")	Yes
PMS 2D-C	(25-800 ")	Yes
PMS 1D-P (200Y)	(0.3-4.5 mm)	Yes
PMS 2D-P	(0.2-6.4 mm)	Yes
Ice Particle Counter		No
Particle Replicator		Yes
Icing Rate Meter		No

Cloud Types Sampled: Wide variety

Altitude Range for Data: Up to 10 km ASL

Data Custodian: AFGL/LYC, Hanscom AFB, Massachusetts. (But funding will required to prepare data for use outside of AFGL.)

Remarks: 1 - Data from the hydrometeor probes (including ASSP?) are frequently of limited value due to malfunctions or difficulties in performing analyses.

Reference: Conover and Bunting (1977)

Project: MRI Ice Cloud Study (1974)

Date(s): Jan. - Apr., 1974

Location(s): North central and northwestern United States, and Winnipeg, Canada

Participating Aircraft: MRI (Cessna "Citation")

Number of Flights: 13

Estimated Value of Flights for data on:

Supercooled LWC	OK (See note 2) Est. Max SLWC: .3 g/m ³
Snow	?
Ice Particles	OK
Graupel	?
Hail	---
Rain	---
Freezing Rain or Drizzle	---

Cloud Physics Probes in Use:

JW LWC Meter	(1-45 μ m)	Yes
PMS ASSP	(3-45 ")	Yes
PMS 1D-C (200X)	(20-300 ")	Yes (See notes 1, 3)
PMS 2D-C	(25-800 ")	No
PMS 1D-P (200Y)	(0.3-4.5 mm)	Yes (See note 3)
PMS 2D-P	(0.2-6.4 mm)	No
Ice Particle Counter		No
Particle Replicator (Formvar)		Yes (See note 3)
Icing Rate Meter		No

Cloud Types Sampled: Ci; uniform, deep winter ice clouds; jet stream clouds.

Altitude Range for Data: 10 to 37 k ft. (3 to 11 km) ASL

Data Custodian: ? Inquire at NCAR Convective Storms Division, Boulder, Colorado
(Principal Investigator: Dr. Andrew J. Heymsfield)

Remarks: 1 - Some uncertainties about probe response?

2 - Some LWC detected at temperatures below -30°C.

3 - No information on particle shape, except from Formvar samples. Good categorization of shape and size vs. temperature and updraft velocity.

Reference: Heymsfield (1977), Heymsfield and Platt (1984)

Project: Illinois PEP* (1973)

*Precipitation Enhancement Experiment

Date(s): June - July, 1973

Location(s): Illinois, Missouri

Participating Aircraft: Pennsylvania State Univ. (680E "Air Commander")

Number of Flights: 17

Estimated Value of Flights for data on:

Supercooled LWC	OK (See note 1) Est. Max SLWC: 3.7 g/m ³
Snow	---
Ice Particles	---
Graupel	---
Hail	---
Rain	---
Freezing Rain or Drizzle	---

Cloud Physics Probes in Use:

JW LWC Meter	(1-45 μ m)	Yes
PMS FSSP or ASSP	(3-45 ")	No
PMS 1D-C (200X)	(20-300 ")	No
PMS 2D-C	(25-800 ")	No
PMS 1D-P (200Y)	(0.3-4.5 mm)	No
PMS 2D-P	(0.2-6.4 mm)	No
Ice Particle Counter		No
Particle Replicator		?
Icing Rate Meter		No

Cloud Types Sampled: TCu, Cb, Cu, Ac

Altitude Range for Data: 10-20 k ft. (3-6 km) ASL

Data Custodian: ? Inquire at Illinois State Water Survey, Champaign, Illinois

Remarks: 1 - No PMS probes for comparison, and nearly all flights made at 0°C to -3°C levels.

Reference: Ackerman, et al (1979)

APPENDIX B

RATINGS OF DATA UTILITY FOR SOME OF THE INDIVIDUAL FLIGHTS

There is usually a non-trivial amount of work and time, and sometimes a significant expense involved in obtaining and processing computerized tapes from the various sources of data. For this reason it is practical to evaluate or rate the flight projects for data utility and quantity on a flight-by-flight basis, if possible, before ordering data tapes for any of the flights.

Evaluations are usually most successful if flight notes are available from experienced observers on board. Adequate evaluations are usually also possible if daily flight operation summaries are available, as for the HIPLEX and SCPP projects, for example.

The evaluations provided in this appendix are samples of those made to date by the author. They are especially helpful in separating less useful flights (because of instrument malfunctions, poor cloud conditions, etc.) from flights of high interest (because of large SLWC values, unusually severe airframe icing conditions, etc.). Because of space limitations only samples of the available flight evaluations are given here. Copies of the remaining evaluations may be obtained from the author upon request.

The individual flights have been rated on a number of aspects, such as the time the aircraft spent in clouds above the freezing level, the abundance of various hydrometeor types, sensor performance, etc., as seen on the individual rating forms. The ratings indicated by the letters A, B, C, D, F are based on a standardized grading system which was devised for the present purposes and which is explained in Table B-1.

Rating forms which are available at this writing are arranged according to agency as follows:

<u>Agency</u>	<u>No. of Flights Rated</u>
Univ. Washington (CYCLES, etc.)	62
Univ. Wyoming (CCOPE:1981)	27
NCAR (News:1982-83)	9

The flights were evaluated from transcripts of the voice recordings made during the flights.

TABLE B-1. DEFINITIONS USED FOR UTILITY RATINGS FOR INDIVIDUAL FLIGHTS

Definition of Ratings for Environmental Conditions

1. Cloud Amount. Ratings apply to cloud conditions within the operating range (vertically and horizontally) of the aircraft in use.

A - Massive or extensive cloud(s) available for sampling.

Layer clouds: Continuous overcast, 5000 ft thick or more.

Convective clouds: Strong convective activity with plentiful, large, growing, or mature towering cumuli (Cu) or closely packed Cu towers. One or more growing or mature thunderstorms or large cumulonimbi with showers or steady precipitation.

B - Unusually good cloud coverage or cloud population.

Layer clouds: One or more relatively thick (3000-5000 ft), relatively extensive layers, but which may be broken or cover only a part of the accessible sky.

Convective clouds: Good convective activity, but may be localized or scattered. Generally have towering cumuli which may occasionally produce showers or grow to thunderstorm size.

C - Flight is worth analyzing for cloud data, but cloud conditions are only mediocre.

Layer clouds: Generally broken overcast, or relatively thin (1000-3000 ft) layers.

Convective clouds: Moderate convective activity and moderate vertical development. Vertical development insufficient to produce showers or thunderstorms.

D - Flight is only marginally worthwhile for cloud data. Flight is worth analyzing only if a special case is involved.

Layer clouds: Thin (less than 1000 ft) layer(s) or not very extensive.

Convective clouds: Weak or shallow convection. Clouds widely scattered and/or not very wide or deep; (eg. fair weather Cu or strato cumulus; lenticular or wave clouds).

F - Flight not worth analyzing for cloud data.

Clear or nearly cloudless skies.

S - Special Case: Flight is of special interest because it involved an unusual type of cloud, weather situation, altitude range, temperature range, geographic location, or mesoscale influence.

TABLE B-1. DEFINITIONS USED FOR UTILITY RATINGS FOR INDIVIDUAL FLIGHTS (contd)

2. Aircraft sampling adequacy

- A - Excellent sampling. Multiple profiles or samples at multiple levels in clouds. Total sampling time in subfreezing portions of clouds exceeds 2 hours.
- B - Above average sampling. Sampling time in subfreezing portions of clouds totals 1-2 hours. Cloud penetrations are generally well above cloud base but may not be at multiple levels.
- C - Mediocre sampling. Sampling time in subfreezing portions of clouds totals 1/2 to 1 hour. Cloud penetrations are generally well above cloud base but may not be at multiple levels.
- D - Flight is worth analyzing only if a special case is involved. Flight level(s) nearly all at temperatures warmer than freezing, or flight was nearly all at cloud base level. Or flight was very short or aborted, or most of time was spent above, below, or between clouds such that not more than about 15 minutes was spent in clouds.
- F - Flight time in clouds is practically zero.

3. Icing Conditions

- A - Unusually severe icing conditions.

Flight notes mention:

- a) Total ice accumulation of 3/4 inch or more by end of the flight, or
- b) One or more references to "heavy" icing, or
- c) Aircraft has to descend to warmer air two or more times to melt off accumulated ice.

- B - Moderate icing conditions.

Flight notes mention:

- a) Total ice accumulation of about 1/4 to 3/4 inch by end of flight, or
- b) One or more references to "moderate" icing, or
- c) Aircraft has to descend to warmer air only once to melt off accumulated ice.

TABLE B-1. DEFINITIONS USED FOR UTILITY RATINGS FOR INDIVIDUAL FLIGHTS (contd)

C - Light icing conditions.

Flight notes mention:

- a) Total ice accumulation of less than 1/4 inch by end of flight, or
- b) One or more references to "light" icing, or
- c) No references to airframe icing but data analyst estimates from the OAT, LWC, and cloud condition references that light icing conditions probably existed.

D - Trace icing conditions.

Flight notes mention:

- a) One or more references to "trace" or "some" icing, or
- b) Flight was almost entirely in snow, or glaciated clouds, or
- c) No references to airframe icing but data analyst estimates from the OAT, LWC, and cloud condition references that trace icing conditions probably existed.

F - No icing likely, because the air was too warm at flight level or the clouds were too shallow and scattered.

4. Hydrometeor Abundance.

Flight through a shower of hydrometeors of a given type is mentioned in the flight notes...

A - 6 or more times or nearly continuously throughout the flight. Or, an unusually large concentration of the given type of hydrometeors is documented 2 or more times during the flight.

B - 4 or 5 times throughout the flight. Or, an unusually large concentration of the given type of hydrometeors is documented once during the flight.

C - 2 or 3 times throughout the flight.

D - Only once throughout the flight.

Types of hydrometeors are coded as follows:

I = ice particles (maximum diameter ~0.3 mm)

S = snow (minimum diameter ~0.3 mm)

G = graupel

R = rain

A = hail

TABLE B-1. DEFINITIONS USED FOR UTILITY RATINGS FOR INDIVIDUAL FLIGHTS (contd)

Definition of Ratings for Data Utility

1. LWC Meter. Ratings actually apply only to supercooled liquid water content (SLWC).

<u>Rating</u>	<u>Definitions</u>
A	a) $SLWC \geq 0.5 \text{ g/m}^3$ throughout most of flight in clouds, or b) $SLWC > 1 \text{ g/m}^3$ at least three times during flight, or c) $SLWC > 2 \text{ g/m}^3$ at least once during flight.
B	a) $SLWC$ ranges between 0.2 and 0.5 g/m^3 throughout most of the flight in clouds, or b) $SLWC > 1 \text{ g/m}^3$ at least once during the flight.
C	a) $SLWC$ ranges between 0.1 and 0.2 g/m^3 throughout most of the flight in clouds, or b) $SLWC > 0.5 \text{ g/m}^3$ at least once during the flight.
D	a) $SLWC$ rarely exceeds 0.1 g/m^3 throughout the flight, or b) Flight is almost entirely in snow or glaciated clouds, or c) LWC data is faulty for a known and significant portion of the flight.
F	a) LWC data is intermittently or continuously faulty throughout the flight.

TABLE B-1. DEFINITIONS USED FOR UTILITY RATINGS FOR INDIVIDUAL FLIGHTS (contd)

2. PMS FSSP Probe.

<u>Rating</u>	<u>Definitions</u>
A	Flight is almost entirely in liquid droplet clouds free from snow or ice particle artifacts.
B	Not more than 25% of the flight is in snow or glaciated clouds where artifact contamination is likely.
C	Up to 50% of the flight is in snow or glaciated clouds.
D	a) Most or all of the flight is in snow or glaciated cloud, or b) FSSP operation is faulty* for a known and significant portion of the flight.
F	FSSP data are intermittently or continuously faulty* throughout the flight.

3. Other Particle Probes

<u>Rating</u>	<u>Defintions</u>
	The hydrometeors to which the probe is sensitive have a:
A	Hydrometeor abundance rating of "A"
B	Hydrometeor abundance rating of "B"
C	Hydrometeor abundance rating of "C"
D	a) Hydrometeor abundance rating of "D", or b) Probe operation is faulty for a known and significant portion of the flight.
F	Probe operation is intermittently or continuously faulty throughout the flight.

*FSSP faults include intermittent operation, loss of recorded data, spurious counts in clear air, interference from ice accretion on the probe, or miscalibration or undercounting that is either uncorrectable or correctable only with great difficulty or uncertainty.

TABLE B-2. SAMPLE UTILITY RATINGS FOR INDIVIDUAL FLIGHTS.

Project: U. Wash., UTAH Expts. Flight Day: Feb. 26, 1981

Flight No. 970 Location: Utah

Time: 0510-0930 Flight Levels: 7-16 kFt.
(Start out before dawn!)

Freezing level: Aircraft Used: U. Wash. (B-23)

Sensor problems: 1D-P, IPC; TAS intermittent.

OAT Range: -2 to -12°C. Ice Particle Conc. Range: 1- 10/liter

	---Cloud Base-----	----Cloud Top---
<u>Cloud Types</u> :	<u>Height</u> <u>Temp (°C)</u>	<u>Height</u> <u>Temp (°C)</u>
Sc,St,As	6-7 kFt msl	12-13 kFt ~-12°
		8-9 kFt ~- 3°

Environmental Conditions:	A	B	C	D	F
Cloud Amount		*			
Aircraft Sampling		*			
Icing Conditions	*				
Hydrometeor Abundance	I	S			
Data Utility:	A	B	C	D	F
LWC Meter			*		
ASSP			*		
1D-C(200X)	*				
2D-C	*				
1D-P(200Y)					*
2D-P	*				
Ice Particle Counter					*
Particle Replicator					
Icing Rate Meter					

Remarks: 1 - Light-moderate snow during early part of flight but none sticking on snowstick. Mid-late part of flight had moderate LWC with total 3/4" to 1" ice accumulation on snowstick.

Hydrometer Code: S=snow, I=Ice Particles, G=Graupel, R=Rain,
A=Hail

APPENDIX C

ADDRESSES OF PROJECT PARTICIPANTS

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